MODERN OPERATIVE SURGERY

EDITED BY THE LATE

G GREY TURNER

LL.D D.Ch M.S., F.R.C.S., F.R.C.S.E., F.R.A.C.S. F.A.C.S.

Professor of Surgery in the University of London and Director of the Department of Surgery at the British Postgraduate Medical School Surgeon Hammersmith Hospital
Emeritus Professor of Surgery in the University of Durham
Honorary Consulting Surgeon, Royal Victoria Infirmary Newcastle upon-Tyne

AND

LAMBERT CHARLES ROGERS

V.R.D M.Sc., M.D F.R.C.S., F.R.C.S.E., F.R.A.C.S., F.A.C.S.

Professor of Surgery University of Wales Director of Surgical Unit Cardiff Royal Infirmary Surgeon, United Cardiff Hospitals Adviser in Surgery Welsh Regional Hospital Board Consultant in Neuro urgery to the Royal Navy Member of Council and formerly Member of Court of Examiners and Vice President, Royal College of Surgeons of England

WITH A FOREWORD BY

SIR GORDON GORDON-TAYLOR

K.B.E., C.B M.A., LL.D Sc.D M.D., M.S F.R.C.S., F.R.C.S.E., F.R.C.S.I F.R.A.C.S F.A.C.S.

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CHAPTER XXIII

OPERATIONS FOR HERNIA

By G GREY TURNER

History —Operation for the radical cure of hernia is one of the oldest of surgical procedures and many methods have been employed Those known by the names of their authors Wood Czerny Annandale Mitchell Banks Ball Macewen and Kocher to mention only a few described during the period 1876–90 have now mainly an historical interest Incidentally it is important to remember that a great deal of the detail of modern wound treatment has been evolved in connection with the radical cure of hernia. The greatest advance in the operation resulted from Bassini s work first described in 1888 * The fundamental steps consisted in dividing the fibres of the aponeurosis of the external oblique sufficiently to expose the whole of the inguinal canal separating the sac from the cord to the highest possible point transfixing and tying it at the neck removing the sac transplanting the cord and suturing the conjoined tendon behind the cord to the inner surface of Poupart s ligament. This soon became the standard operation and forms the basis of most methods at present in use Modifications have arisen from time to time the most important being the Wölfler operation similar in all respects to Bassini s except that the cord is not transplanted and resembling the Bevan operation which has a particular value in the cure of congenital hernia in children with incomplete descent of the testis

Halsted in 1890 modified the Bassini operation by dividing not only the external oblique but also the internal oblique and transversus muscles and the transversalis fascia to a point 1 in. external to the internal ring forming a new internal ring external to the original one transplanting the cord which had been stripped of most of its vessels and uniting all the divided muscular and aponeurotic structures behind the cord which thus came to lie directly under the skin Lockwood displaced the neck of the sac after transfixion and ligation high up under the transversalis muscle by passing the long ends of the ligature through the transversalis and internal oblique muscle from within outwards and tying the ends together on the surface of the internal oblique under cover of the aponeurosis of the external oblique. Polya in 1905 † realizing that recurrence takes place if at all at one of two points—(*a*) at the lower angle of the canal or (*b*) at the entrance of the cord to the canal—adopted the Halsted method of resecting the redundant vessels of the cord and displacing the latter

* On December 23rd, 1884, Bassini carried out the first of the operations for hernia now known by his name Four and a half years later the patient was found to be free from recurrence which was considered a remarkable result at that time

† *Centralbl. f Chir* 1905 No. 9 xxxii, 210.

To strengthen the weak spot at the lower angle of the canal he opened the sheath of the rectus for a distance of some two inches from its pubic attachment mobilized this muscle and sutured it to Poupart's ligament

Thus for over sixty years the root idea of Bassini's operation has been accepted and such variations as have been suggested have had for their object the strengthening of degenerated structures or details of technique Bassini's operation is admittedly adequate where muscular development is satisfactory e.g in the ordinary oblique inguinal hernia of congenital type occurring in children or healthy young adults When the hernia is associated with or has resulted from weakness or degeneration of the abdominal muscles particularly of the conjoined tendon additional steps such as the overlapping of the external oblique aponeurosis the use of the rectus muscle or sheath or the employment of fascial or other special sutures are indicated. Especially is this the case in direct inguinal hernia.

From time to time surgeons have supplemented their efforts at radical cure by the use of metallic suture material In 1909 Lawrie McGavin published* an account of silver wire filigrees buried in the hernial sites where they are intended to remain and after incorporation with the tissues to act as barriers against recurrence The lapse of time is showing that this plan has attained more success than has previously been acknowledged. In their search for some yet better method Gallie and Le Mesurier† experimented with strips of fascia lata used as sutures This was soon recognized as a new principle for it was proved that the strips become incorporated with the tissues and survive as a permanent addition to the architecture of the areas in which they are employed. Their first paper was published in 1924 and since that time the method has been subjected to an extensive world wide trial and is recognized as a great addition to the solution of the hernia problem

A revival of interest in the old method of injection for the cure of hernia took place some years ago and was conscientiously subjected to further trial notably by Delisle Gray and A. E Porritt‡ in this country

In every decade there are surgeons who become dissatisfied with the results of operations designed for the radical cure and this attitude is always intensified in war time The winter of their discontent does nothing but good for it is well that the attention of the profession should be focused on those procedures which lacking the elements of novelty are too often treated with dangerous complacency But all who have looked into this question with unbiased minds have often to admit that the degree of non-success which they deplore is due to causes which are preventable. Too often the operation for the radical cure is regarded as trivial or unimportant and left to enthusiastic but inexperienced juniors who have often but a superficial knowledge of the anatomy of the parts concerned and a poor

* *Brit. Med. Journ* Aug 14, 1909
† *Brit. Journ. Surg* 1924 xii, 289
‡ *Proc Roy Soc of Med* 1935, xxx 603.

understanding of the essentials necessary for repair Even with ampler knowledge they often lack the technical skill which should be brought to every detail of this operation which is often of such importance for the comfort and welfare of the patient and for his economic position

The history of the operative management of hernia throughout the last half-century has emphasized the fact that all hernias of any group are *not necessarily the same and that individual consideration is* required in planning their management Unfortunately the basis for the management of hernia remains hypothetical for with the exception of the presence of a congenital sac or the assumption of inherent weakness the cause is not known The anatomical aspect of the problem has been minutely studied in still life throughout the ages but there is much more to be done on the study of the living functional anatomy Such studies should be made in the conscious patient and when in the vertical as well as the horizontal position Lytle* of Sheffield has already made contributions along these lines

Methods available.—There are only two methods which hold out a prospect of permanent cure in hernia—open operation and closed injection The latter only requires mention in a work on operative surgery It has the one outstanding advantage that it is ambulatory and in fact many patients continue to follow their occupation while undergoing treatment The method is usually limited to inguinal hernias that are completely reducible and can be efficiently controlled by truss which *must* be worn continuously throughout the treatment Whilst *the size of the hernia seems to be of little importance provided* it is completely reducible an excess of subcutaneous tissue is a contra indication From 8 to 12 injections are required at twice-weekly intervals Complications are few but local inflammations and even peritonitis have occurred. The recurrence rate is stated to be about 8 per cent but it is said that some of these can be successfully treated by a further series of injections No large series of cases appears to have been followed up over a period of several years

In spite of anything that can be said in its favour the method has never been generally adopted in this country In America the method has been fairly extensively used (*a*) in vigorous healthy young men who wish to escape hospitalization and (*b*) in old feeble subjects in order to avoid the possible risks of open operation and the necessary confinement to bed

Principles of operation.—The principles underlying the radical cure of all hernias are the same namely the complete isolation and removal of the whole sac and the restoration and strengthening of that part of the abdominal wall through which the hernia has protruded To attain these objects very numerous plans have been adopted and modifications are constantly being introduced but the prospect of their success depends on the observance of these principles

* *Brit Journ. Surg* 1945, xxxii, 441

Indications for the radical cure of hernia.—In these days there are very few cases of hernia that need be refused operation. Apart from the inconvenience which hernia causes the real danger is strangulation which still claims a mortality of about 20 per cent whereas the mortality of operations for radical cure is considerably less than 1 per cent This alone is a very cogent argument for operation. An attack of strangulation even if the patient recovers without surgical interference is always an indication for subsequent operation for this complication is very apt to recur With the methods of treatment now available diabetes or renal and cardiac disease are no longer absolute contra indications though they each require special measures to render operation justifiable. The greatest barriers to success are ruptures of so great a size that the contents cannot be comfortably returned to the abdomen persistent and incurable cough or advancing obesity which cannot be controlled by diet

In old standing cases it is necessary to be sure that the hernia is not just a cloak for some other disease which is the cause of symptoms the patient unwittingly attributes to his obvious encumbrance. For instance fat women with umbilical hernia often suffer from gall-stones but invariably attribute their biliary attacks to the rupture. Similarly elderly men who have endured the inconvenience of a hernia for years will often begin to think of a radical cure when symptoms due to enlarged prostate become troublesome Many other combinations occur such as obstructive symptoms due to carcinoma of the rectum or the general weakness associated with diabetes which have both been attributed to long standing hernia.

There is a recurring urge to simplify the operation and many conscientious surgeons revolt at disturbing the anatomy of the canal in healthy young adults They claim that it should be enough to completely and thoroughly remove the sac and to do nothing more. But this is a fallacy it is the old operation in common use before the Bassini method was generally adopted and those of us who are sufficiently senior recall the large proportion of recurrences which invariably followed The writer has often been witness to the revival of the practice and always with the same result

The object of intervention.—In children and healthy young adults operation can be undertaken in the confident expectation that the hernia will be permanently cured In elderly and less robust members of the community and in those suffering from very large hernias operation may still be the best treatment not only to remove the dangerous risk of strangulation but to add to comfort and to promote well being but it cannot be undertaken with the same prospect of lasting cure These patients should be warned that if signs of recurrence become manifest they should report for advice. Recurrence in the young adult usually justifies further operation In the more elderly it may be wiser to fall back on a properly fitting and well applied truss If the apparatus is used when the relapse first appears

it will prevent deterioration of the condition and may enable the patients to fulfil those activities for which they are otherwise fitted In this way operation may be the means of exchanging a heavy burden for a manageable inconvenience

Though the surgeon should not be easily deterred he should hesitate to make rash promises about the prospects of radical cure Apart from other factors age is not necessarily a bar to successful intervention but the prospects of radical cure become less likely as the years advance The advantages of the operation have proved so great that its reputation can sustain the opprobrium which naturally attaches to the occasional recurrence

Suture material for the operation.—Many surgeons use chromicized catgut throughout No 8 being suitable for the deep sutures and No 1 for the other parts of the operation The Halsted school still use very fine black silk and there are an increasing number who follow the Kocher technique and use thin Chinese twist silk Floss-silk for lattice repair various kinds of metal wire and wire gauzes are also though less frequently employed Kangaroo tendon seems to have quite gone out But surgical memories are short and it is apt to be forgotten that every now and again troublesome sinuses follow the use of unabsorbable material. Whatever is used it must be realized that the final success of the operation does not depend on the suture material but on the power of the tissues to unite To give them the best chance accurate and close apposition without tension and healing without infection are essential

The use of living sutures introduced almost a new principle in the treatment of hernia.* The method was very carefully worked out by Gallie and his co-workers in Toronto Their experiments showed that the lateral approximation of muscles to fibrous structures results in only a feeble union by scar tissue. They found that living autogenous sutures of fascia or tendon survived and became permanently incorporated with the tissues They used this method in certain types of hernia especially the direct inguinal variety umbilical and ventral hernias incisional hernias and recurrent cases The sutures are cut from the fascia lata or from the external oblique bordering the inguinal canal. When the fascia of the thigh is employed it is either exposed by a long incision on the outer side the strips being cut with a sharp scalpel or strips are cut by a special instrument called a fasciatome which can be introduced through a small skin incision at either end of the proposed suture Generally speaking the open incision and the use of scalpel or scissors has been the most satisfactory The strips are about 10 in long and one-quarter of an inch wide and in an ordinary case two or at most three suffice. The gap left in the fascia is closed whenever possible but little inconvenience has followed when this has not been done provided of course that the skin incision is carefully sutured. Occasionally a large bulging

* Gallie and Le Mesurier Brit. Journ Surg 1924 xii, 289.

hernia of the vastus externus has developed and caused alarm and inconvenience. To avoid this sequel when the fascial wound cannot be closed the edges should be drawn as near together as can be accomplished without tension and then fixed to the underlying muscle by a few points of suture. The strips must be fixed by catgut or silk through the eye of a round needle and the extremity should be tied with a ligature to prevent fraying The Mayo type of round needle answers quite well many of the special fascia needles are

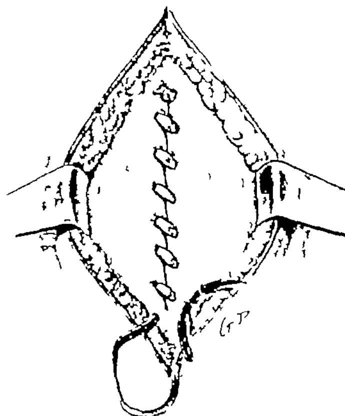


Fig. 477 —The repair of ventral hernia with sutures of fascia lata. The first suture approximates the recti in their sheaths.

This and the following figure are redrawn by permission of Prof. Gallie from his article in the *British Journal of Surgery* 1924, xii, No. 46, 280.

too thick and bulky and cause an unnecessary amount of trauma. It is more convenient to thread the strips before the opposite end is cut away from the thigh. It is also a help to have one worker cutting the strips from the thigh opposite to the hernia and handing them ready threaded to the operator These sutures are sometimes used in place of catgut or other material for approximation of the muscles in routine operations for hernia or they may be employed to supplement ordinary sutures whether of catgut or silk Where the edges cannot be approximated without great tension or where there

are apertures in muscles or fibrous structures as in some cases of direct or ventral hernia the fascial strips are used to make a sort of lattice work between the tissues and across the apertures so that the latter are protected by a mesh of interwoven and interlaced strips as shown in the diagrams copied from Gallie s original article (Figs 477 478) Running sutures are used and some form of lock-stitch is employed every third or fourth bite because of the slippery material The final stitch must be securely fixed by an independent suture ligature of

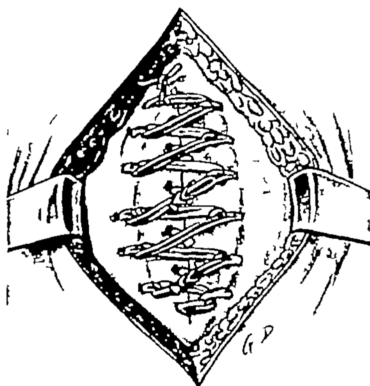


Fig. 478 —A second layer of sutures has been inserted and fixed.

catgut Similar care must be taken to attach one suture to the next if a particularly long lace is required for darning In the hands of the originators and indeed in others who have reported cases * the results have been very satisfactory But it must be stated emphatically that fascial sutures are only adjuncts in the radical cure and do not compensate for want of care in carrying out every detail of the operation In 1930 Gallie and Le Mesurier† reported a series of nearly 200 cases with only 6 known failures Many of the cases supplied the severest possible test for among the first 50 there were ex soldiers suffering from recurrence after one two and sometimes three operative

* Keynes, *Brit. Med. Journ.*, Jan. 29 1929 i, 44
† *Journ. Canad Med Assoc.*, xxiii, 163.

attempts at radical cure There were also ventral and inguinal hernias so enormous as to be almost unbelievable and several were in patients suffering from chronic bronchitis and asthma in whom the hernia had recurred because of uncontrollable cough. This résumé indicates the sort of case in which these sutures can be most usefully employed.

Floss-silk lattice repair.—This is a similar method and suitable for the same types of case but the suture material is non absorbable and to be classed as a foreign body The idea of making a lattice seems to have been introduced by Sampson Handley who called it The darn and stay lace method. * He used ordinary stout silk. The plan of using floss-silk has now had an extensive trial and seems to work very well Its success depends on punctilious care in execution with perfect asepsis and hæmostasis The floss-silk can be satisfactorily sterilized by boiling and is much less likely to be extruded than ordinary thick silk and is much more convenient to handle than the fascial strips. It seems to be kindly tolerated by the tissues and sepsis associated with it is rare. When it does occur the suture will probably require to be removed while the infection is treated by antibiotics Rodney Maingot has used the method freely† and gives a very careful description of the technique employed. In 100 consecutive cases there were only two examples of infection As a radical cure permanent success seems to have been obtained in a high proportion of cases

The double filigree method.—On general principles it is unwise to bury unabsorbable foreign bodies in the tissues Nonetheless silver wire filigrees (size 28 S W G) have been used to reinforce the hernial region and have seldom caused trouble. In the second edition of this work (1934) it was stated that the fascial suture method had entirely superseded the filigree but time has shown that the wire support may occasionally be used with success when the fascial suture has failed Cases have now been watched over a period of many years and the results for radical cure have been very satisfactory The recurrence rate has been small and only 12 could be traced out of 448 operations. In only very few instances has the filigree worked loose or had to be removed. At the Dreadnought Hospital (Greenwich) the method has been continuously in use since its introduction by Lawrie McGavin over forty years ago (1909).‡

Technique.—The operation should be carried out under good anæsthesia producing perfect relaxation and abdominal quietude during the immediate post-operation period which are essential. Very strict asepsis and hæmostasis must be observed and every step of the operation carried out with great care. The late Percival Cole always practised a non touch technique to which he attached much importance The canal is freely exposed and the sac dealt with

* *Practitioner* 1918, 48
† *Lancet*, June, 1940 801
‡ Percival P Cole, *Brit Journ Surg*, Oct 1941 xxix, No. 114, 168.

as in other types of radical cure A bed must then be prepared for the filigree over the structures forming the posterior wall of the canal If the transversalis fascia is intact it forms the best foundation but any rents in it should be repaired and loose tissue in the neighbourhood drawn over it The lower arched fibres of the internal oblique and the outer border of the rectus are defined so that the edge of the filigree can be slipped beneath them A filigree must be selected which will cover the whole of the posterior surface of the canal and

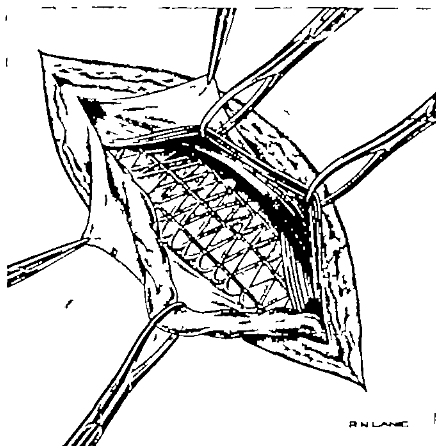


Fig 479 —Reinforcing the hernial region by means of a double filigree

will lie flat without any tilting of its edges It should fit so snugly that fixation by suture is unnecessary The oblique muscle and sometimes the rectus are then sutured to Poupart s ligament behind the cord but superficial to the filigree and this sufficiently holds it in position After replacing the slack of the cord in the scrotum the superficial filigree is placed over the sutured muscles so that its lower end extends well below the deep filigree i e farther towards the pubes This filigree is kept in position by suturing the external oblique over it using the overlapping method when possible Much care is taken in the approximation of both the deep fascia and the skin. The patient must lie very quietly for the first few days Occasionally a collection of serum forms at the outer end of the incision but it can be safely evacuated and will not delay healing for long

Three weeks should be spent in bed and heavy work should not be resumed sooner than four months after operation *

Human skin.—Sutures or patches of full thickness skin cleared of all subcutaneous tissue and fat have also been employed It has been found that in the course of months the skin is replaced by dense fibrous tissue Infection can almost certainly be eliminated and secondary developments such as traumatic dermoid have only very rarely followed. The method is interesting but if it has advantages they are not yet obvious and have yet to be proved

Preparation for operation.—There can be no excuse for operating on hernia without proper examination and necessary preparation for apart from strangulation there ought to be no urgency In the elderly it is not enough to be assured that the urine is normal and it should be established that renal function is satisfactory The causes of even slight cough should be sought and treated for this may make a great difference not only in convalescence but to ultimate success Abdominal distension must also be overcome while purgation is not necessary the large bowel must be cleared but any enema required for that purpose should be given on the day before operation In very large hernias the patient should be kept in bed for a few days with the head low and high blocks under the foot end. This not only helps to reduce the size but gets the patient accustomed to lying on the back and tolerating the addition of all or part of the hernial contents to the abdomen

Special care should be taken in the skin preparation as the region of the groin is apt to harbour dirt and infection and the skin is often moist and may be affected by intertrigo The same remarks apply to umbilical or ventral hernia in which folds of skin and deep sulci are concerned Ordinary social cleanliness is important and preliminary shaving bathing etc should be carried out thoroughly on the *previous day In inguinal and femoral hernias it is wise to indicate* the side to be operated upon by a cross or other mark made with an indelible pencil or some dye such as carbol fuschine on the thigh or elsewhere to prevent the mistake of operating on the wrong side.

Anæsthesia.—For routine work and in most cases careful general anæsthesia is efficient and convenient but there are many cases in which local anæsthesia is indicated and especially those complicated by strangulation There is no hernia however large which cannot be operated upon under local infiltration combined with regional anæsthesia though it requires patience and care consumes a good deal of time and sometimes seems to interfere a little with wound healing The operation takes longer and those who have been operated upon by both methods sometimes complain of the after pain of the local anæsthesia and usually prefer the general inhalation methods. Spinal anæsthesia is efficacious but has its own special risks.

* For further details see *Brit Med. Journ* Aug. 14 1909 ii, 337 *Lancet*, Feb. 23, 1924 i, 385, and May 22, 1926, i, 974 and also above reference.

OBLIQUE INGUINAL HERNIA

Bassini's operation—This operation has yielded such good results in the hands of so many surgeons the world over that it is properly regarded as the standard method to be employed unless there are special reasons for adopting some other plan The steps of the operation may be thus epitomized (1) exposure of the whole canal by an adequate incision through skin and subcutaneous tissues

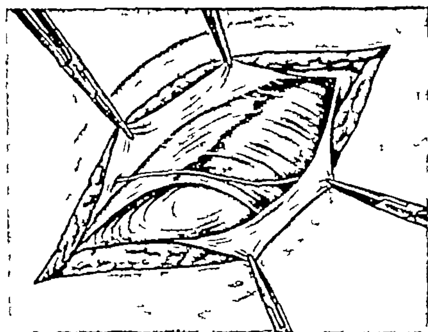


Fig 480 —Radical cure of left inguinal hernia aponeurosis of external oblique incised exposing conjoined tendon and ilio-hypogastric nerve.

(2) division of the external oblique muscle from the external ring to a point well above the level of the internal ring (3) identification and opening of the sac with treatment of contents (4) separation and isolation of the sac to the highest possible point which ought to be well above its neck (5) ligature and removal of the sac (6) the formation or reconstruction of the posterior wall of the canal by repair of the transversalis fascia and suture of the lower edge of the internal oblique and transversalis muscles and the conjoined tendon to the inguinal (Poupart s) ligament behind the cord (7) repair of the external oblique muscle the margins being overlapped if the structure is at all lax (8) careful suture of the skin together with the whole depth of subcutaneous fat

Technique —An incision is made parallel with Poupart s ligament and ½ in above it from a point just above the spine of the pubis to a point an inch or so external to the middle of Poupart s ligament If this can be made in a natural crease as sometimes happens in children or fat subjects it is an advantage In very stout subjects the incision must be much longer depending upon the amount of subcutaneous fat It is carried throughout its whole length down

to the aponeurosis of the external oblique exposing and dividing at right angles the superficial external pubic and superficial epigastric vessels which must be secured if possible before they are divided. On exposure of the aponeurosis its fibres are seen to be parallel with the incision separating below and medially to form the external ring The aponeurosis is divided with a sharp scalpel in the line of its fibres starting from the external ring The two flaps are dissected back, the upper one so as to expose the conjoined tendon for a distance of ¾ in. the lower to expose the upper grooved surface of Poupart s ligament. In reflecting the upper flap care must be taken to recognize and safeguard the ilio-hypogastric nerve which runs on the outer surface of the conjoined tendon parallel with and ½ in from its free edge. This nerve if divided or caught in a suture might give rise to pain during convalescence The conjoined tendon (internal oblique and transversalis) is now seen arching over the cord from above downwards and inwards (Fig 480) The attachment of the lower fibres of the muscles to Poupart s ligament in the outer part of the incision must be carefully preserved. The ilio-inguinal nerve is defined and safeguarded. The cord and hernial sac are exposed at the inner end of the incision as they pass towards the scrotum If the sac is occupied it may form a bulky mass but if empty and thin it may scarcely add to the size of the cord The cord with the sac is then lifted from its bed and the position of the vas and the main vessels defined. The sac is now exposed by incising or separating the coverings with the dissecting forceps The cremaster muscle varies very much in bulk and strength as a rule its fibres can be separated but they may have to be incised

If there is difficulty in finding the sac the surgeon must take time to orientate himself as it is easy to miss a thin empty sac. Such a sac may be identified by the rounded edge of its fundus and if the hernia is small this may be situated just outside the internal ring In a big long sac the fundus is in the scrotum and when empty and thin walled the sac may not be obvious among the structures of the cord, especially remembering that with a congenital sac these structures are spread out over its surfaces The plan is to incise more deeply in the length of the cord with the object of opening into the sac. When this is accomplished the smooth glistening inner surface establishes its identity at once very often the sac contains a little fluid. Once the sac has been found it is a great help in further separation to introduce the finger Having been found the sac is caught in forceps and the process of separation from the structures of the cord is continued. This can usually be done easily with dissecting forceps aided by gauze stripping If the sac is very adherent it is more easily manipulated and opened with the finger introduced into its interior as a tractor If it is very bulky because of its contents the latter are better returned to the abdomen before further separation is attempted. The contents may be adherent and bands may have to be exposed and divided care being taken to apply ligatures to any bleeding structure that is to be

returned to the abdomen On the other hand broad areas of bowel may be adherent to the sac and will have to be very carefully separated with scissors The contents may be free so far as the body of the sac is concerned but may be adherent all round the neck and cannot be reduced until released Very firm adhesions of bowel to the fundus of the sac may be dealt with by cutting away a portion of the sac

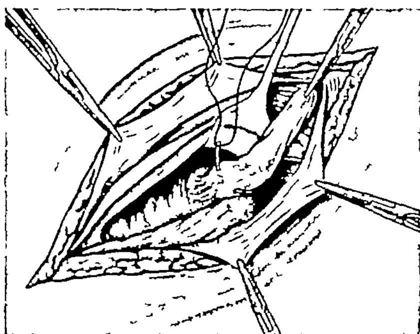


Fig 481 —Radical cure of left inguinal hernia sac isolated and transfixed, preparatory to ligature. While this step is being carried out, the sac should be held taut, and the ligature should be placed at the highest possible point. In this figure the sac is not sufficiently on the stretch, and the ligature is not high enough

and leaving it attached to the bowel to be returned to the abdomen with it After the sac is completely emptied its separation is continued.

If the fundus is very densely adherent to the structures of the cord the sac may be cut across and the fundus left attached to the cord This plan was devised by A E Barker and is sometimes advisable as it avoids the hæmorrhagic oozing and the risk of hæmatoma that may follow the separation of a very adherent sac. The fundus having thus been freed the surgeon takes the sac in his hand and makes strong traction at the same time using gauze stripping to clear the parts about the neck In this way it is isolated to the highest possible point Care must be taken not to injure the deep epigastric artery which is often seen on the inner side of the neck if the separation has been sufficiently thorough The neck of the sac is transfixed with a ligature of No 1 chromicized catgut This is securely tied around one half and then around the whole The sac is now cut away and if it has been ligatured sufficiently high up the

stump will retract into the cellular tissue without leaving the funnel shaped depression which might encourage recurrence. When the neck of the sac is very wide it is difficult to prevent the abdominal contents slipping down while the suture ligature is being passed. This may be overcome by twisting the sac at its neck before applying the ligature the latter must be applied above the highest point of the twist If the neck of the sac is torn during separation or ligature it may be better to catch the edges of the hole in artery forceps to cut

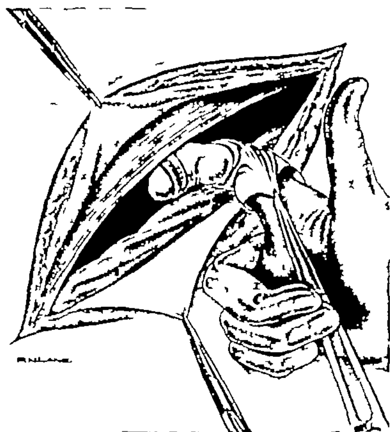


Fig 482 —Pouching of sac beneath epigastric vessels. (Left inguinal hernia.)

away the remainder of the sac and then to close the peritoneum by a continuous suture as in laparotomy Sometimes there is an extension of the sac which passes beneath the epigastric vessels and may be prominent to their inner side (Fig 482) Such an extension must be removed with the sac as it may otherwise be a cause of recurrence. The sac having been securely dealt with the next step is to prepare the parts for the insertion of the deep sutures

The cord with the vas are held out of the way with a retractor or a pair of ring forceps and the edge of the lower border of the internal oblique conjoined tendon and Poupart s ligament are systematically cleared of fat It is at this stage that the transversalis fascia comes into view it may have been divided or torn during the separation of

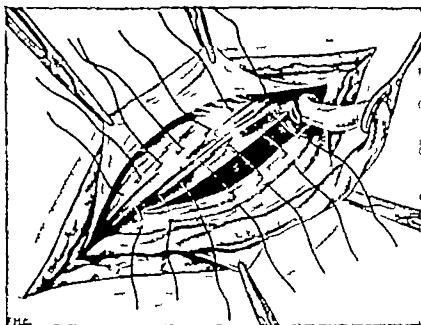


Fig. 483.—Radical cure of inguinal hernia cord held aside suture of conjoined tendon to upper surface of Poupart s ligament. The transversa is fascia should have been shown separately sutured or included in the interrupted sutures as depicted

the sac. The edges of the fascia if well defined should be separately sutured with fine catgut or should be included in the sutures between the internal oblique and Poupart s ligament The internal oblique and conjoined tendon are then sewn down behind the cord to the upper grooved surface of Poupart s ligament by sutures of chromicized catgut No 3 (Figs 483 and 484) The upper suture is applied so as to leave room for the cord to pass without compression

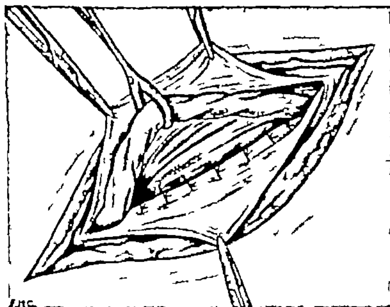


Fig 484 —Radical cure of inguinal hernia further stage of the suture shown in Fig 483.

and the greatest care is taken that the needle in picking up Poupart s ligament does not injure the femoral or epigastric vessels or lacerate this rather delicate structure. A half-circle not too-thick round needle i.e not a cutting needle should be used. The sutures are usually introduced from above downwards and the first step is to place the tip of the forefinger beneath the edge of the upper border of the canal which at this point will be the internal oblique. The point of the needle is inserted half an inch away from the edge of the muscle and is passed completely through the muscle on to the finger which protects the peritoneum and the epigastric vessels In this way a workman like hold of the structure is secured. The ilio-hypogastric nerve must be avoided The point of the needle is then introduced behind Poupart s ligament and this structure is lifted away from the underlying vessels before the needle actually penetrates In this way the vessels are kept out of harm s way On the other hand if the needle is introduced from the exposed surface of Poupart and thrust through to its deep aspect that structure is pressed towards the vessels which may then be in danger of puncture. The suture at the extreme inner end of the canal is very important as it is at this point that recurrence is most likely to appear Some surgeons try to include the periosteum of the pubic bone in the bite of this stitch. All the sutures should be placed before any are tied but even so in bulky patients it may be better to commence placing the sutures at the pubic end and work outwards. It is essential that the sutures be placed exactly at right angles through the two structures so that as little trauma as possible may be done The sutures should not be tightly tied lest the tissues in their grasp be strangled with consequent necrosis or atrophy All that is required is uniform apposition without tension Five to eight of these sutures are usually sufficient When the internal oblique is lax an additional stitch may be placed external to the cord The cord is allowed to fall back on the sewn-down conjoined tendon and the aponeurosis of the external oblique is sewn up with interrupted sutures of No 1 chromic catgut usually with overlapping (Fig 485) The reconstructed external ring must not be too tight and of course depends on the bulk of the cord. Usually it will suffice if it readily admits the tip of the forefinger

The wound is closed without drainage after the most careful hæmostasis It is important that the depths of the subcutaneous tissue should be brought into good apposition and for this purpose three or four of the skin sutures should be carefully passed to include its whole thickness. The extreme skin edges can then be drawn together with fine intermediate sutures or clips. It is especially important that the cord at the inner end of the incision should be protected by subcutaneous fat

In young healthy subjects this operation carefully carried out in all its details probably yields as high a proportion of radical cures as it is possible to obtain In older subjects or in those with poor muscles or when the posterior wall of the canal is very wide or the parts do

not come into apposition without tension the results cannot be expected to be as satisfactory and it is this group which accounts for such a proportion of recurrences as to lead some surgeons to discredit the Bassini operation In such cases catgut sutures may be usefully supplemented by continuous fascial sutures either cut from the edge of the external oblique or from the fascia lata. The keynote to success is thoroughness and the necessary time must not be grudged While 20 minutes may suffice for a very simple case half to three-quarters of an hour is not at all too long to dedicate to its careful completion

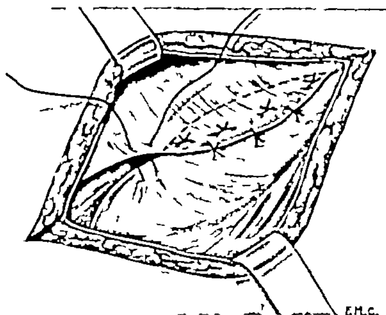


Fig 485 —Radical cure of inguinal hernia suture of aponeurosis of external oblique by overlapping.

Modifications are all of a minor order and all of them retain the main principles of exposure of the inguinal canal by dividing the external oblique aponeurosis the ligature and removal of the sac at the highest possible point and the reconstruction of the canal by suture of the conjoined tendon to the deep surface of Poupart s ligament. The chief modifications concern displacement of the neck of the sac after ligature removal of veins in order to diminish the size of the cord transplantation of the cord closing the upper end of the canal round the cord the use of the rectus muscle or sheath to strengthen the lower end of the canal and overlapping the flaps of external oblique aponeurosis Some operators set great store by the use of non absorbable sutures and silk linen thread nylon and various metallic wires have all been individually extolled.

Displacement of the neck of the sac.—*After* the sac has been tied the ends of the ligature may be threaded on a needle and passed through the muscles from within outwards at a point an inch above and external to the ring The ends of the ligature are then tied on the outer surface of the muscle In this way the ligatured stump is displaced upwards and outwards

Removal of the veins of the cord.—To diminish the bulk of the cord some surgeons systematically remove the veins and this was an essential feature of the original Halsted operation. Atrophy of the testicle not infrequently resulted The method should not be used unless there is a co-existing varicocele or the veins are particularly bulky A leash of veins should always be left with the vas Removal in part or in whole of a bulky cremaster muscle comes into the same category If this is done great care must be taken to secure any vessels supplying the muscle or a troublesome hæmatoma may follow

Transplanting the cord.—It is the general opinion that in operating on infants and especially on cases of hernia associated with imperfect descent of the testis the cord should not be transplanted (i.e. placed in front of the sutured muscles) and this is the custom generally with the round ligament in inguinal hernia in women. In all other cases the cord is transplanted by most surgeons.

In the British Isles the original Bassini method of placing the cord between the sewn-down internal oblique and the aponeurosis of the external oblique is the rule. Halsted s transplantation between the aponeurosis of the external oblique and the skin is not often done and appears to be of no advantage When the muscles are very lax the external oblique may be overlapped and fixed by suture. This may be done from above downwards or from below upwards the cord being left in the Bassini position. (Fig 485)

Torek maintains that the sac comes down between the vas and the spermatic vessels which meet at an angle at the internal ring and to secure radical cure he separates the vas and cord widely and sews the conjoined tendon down to Poupart s ligament between them making the vessels come through at the upper end of the canal and the vas at the lower The lower end of the canal is reinforced by suturing the rectus muscle in its sheath to Poupart s ligament

W J Lytle s views on the internal abdominal ring and its bearing on the hernia problem* are based on careful anatomical studies mostly of the inner peritoneal aspect of the inguinal region and on observations made during operations for hernia under local anæsthesia. He concludes that the internal ring in the plane of the transversalis muscle and fascia plays an important part in guarding the weak area through which oblique inguinal hernia occurs The efficiency of the mechanism of the ring is dependent on its mobility so that it can be acted upon by the contraction of the transversalis which draws it upwards and outwards behind the lower border of that muscle and the internal oblique. In operating he very carefully and deliberately exposes the edges of the ring while cleaning the neck of the sac. After the latter is separated and ligatured off the stump is allowed to retract and the ring is tightened up and diminished in size by means of a fine continuous suture which draws its edges together from below up to the point of exit of the cord Lytle holds that except where the ring has been very much stretched and weakened as in large or long standing

* *Brit Journ Surg.*, 1945, xxxii, 441

hernia, nothing further should be done so that the normal mechanism of the ring will be unimpeded by distortion or fixidity

Philip Turner's* operation differs in many respects from Bassini's Accepting Hamilton Russell's theory† that all hernial sacs are congenital he adopts a method which he states was independently suggested by G L Cheyne‡ His incision is rather higher than Bassini's and after exposing the external oblique aponeurosis he identifies the upper margin of the external ring and incises the aponeurosis in the direction of its fibres starting a finger breadth above the centre of Poupart's ligament and terminating ½ in short of the upper margin of the external ring thus preserving the intercolumnar fibres Through this opening the sac is separated from the cord after retraction of the conjoined tendon upwards and inwards with a blunt hook The sac is separated at the site of exposure then the lower end is freed and finally the upper end it is then pulled down so as to expose the neck which is transfixed tied and divided The ligature is cut short the stump retracting behind the internal oblique without being secured to the muscle. No attempt is made to suture the conjoined tendon to Poupart's ligament a step which Turner considers unnecessary unless there is secondary muscular weakness The incision in the external oblique aponeurosis is closed with a continuous suture and the incision in the skin is sewn up

Sir Cecil Wakeley§ advises that the fascia transversalis should be sutured to Poupart's ligament and the lower flap of the external oblique to the transversalis fascia the operation is then completed by the suture of the edge of the upper flap of external oblique to the lower flap behind the cord. Because in his view it is impossible for muscular tissue and tendon to unite no attempt is made to suture the conjoined tendon to Poupart's ligament

Dressing and after treatment—The dressing should be anchored over the lower end of the incision with a silkworm stitch Wool and a spica bandage should be applied in all cases as the patient needs this support during the stage when there may be vomiting and coughing Retention of urine during convalescence does not seem to be nearly so common as formerly If the patient is ignorant of the possibility and is treated with an easy confidence and assurance the catheter will probably not be necessary After about the fourth day patients may be allowed to move freely in bed and should be encouraged to systematically move the arms and legs and to turn on one or other side Such activities are often systematized as bed exercises and after rising are followed by regulated walking stooping etc the whole being regarded as in the process of rehabilitation If wound healing is satisfactory the patient may be allowed out of

* Inguinal Hernia, 1919, London, Churchill
† *Lancet*, 1899, ii, 1353 1902, i, 1519 1904, i, 727
‡ *Brit Med. Journ.*, 1907, ii, 1300
§ *Lancet*, May 4 1940 i, 822

bed during the third week and may begin to walk. Occupations not involving strain or long standing may be resumed in five weeks but laborious work should not be started until three or four months after a satisfactory operation and wound healing

Local complications and sequelæ.—*Injury to the bladder* rarely occurs but when it does is always potentially serious This matter is dealt with at p 1254 *Division of the vas* is most likely to occur in children or elderly men (*see* p 1255) *Injury to the vessels*—The deep epigastric may be divided if a cutting needle is used without proper care. In former days this mishap was sometimes followed by fatal hæmorrhage into the extraperitoneal tissue. With the better exposure now employed the accident will almost certainly be disclosed as it happens Both ends of the vessel must be exposed and securely ligatured The iliac vessels may also be injured (p 1255) *Hæmatoma* of the cord may give rise to a hard mass or nodule which is always mistaken by the patient for a recurrence causing much disappointment and anxiety Beyond a suspensory bandage and reassurance no special treatment is necessary but it may be several weeks before absorption is complete *Ærocele*—On very rare occasions the area from which the sac has been removed becomes occupied by imprisoned air This will always safely absorb but if the process is unduly slow the air may be removed by aspiration *Hydrocele* may occur but is not nearly so frequent since surgeons have given up removing the veins of the cord When it occurs it should not be hastily interfered with Tapping and the use of a suspensory bandage are often followed by cure. *Atrophy of the testicle and painful testicle* only occur when the blood supply of the organ has been interfered with either by removal of the veins or their obliteration following thrombosis which may be a rare sequel to the inevitable handling during operation. *Painful scar* is another but fortunately rare sequel The cause is obscure and the condition does not yield to local treatment Most benefit follows physiotherapy

The operation to be employed at various ages.—In this matter there are no definite criteria A useful working rule is as follows —Up to two years of age the sac is separated and ligatured off as high as possible without dividing the external oblique One or two sutures may be used to draw the external ring together if the hernia has been very large. Between two and twelve years the external oblique is divided over the canal so that the sac can be isolated and ligatured off at the highest possible point and the conjoined tendon is sutured to Poupart s ligament superficial to the cord i e without displacing it After twelve years of age the Bassini operation is always employed unless there is definite indication for some other type of operation.

Bilateral inguinal hernia.—It has been suggested that there is a greater risk of recurrence when operations for double inguinal hernia are carried out at the same sitting and there is some statistical evidence

in support of this contention It is probably quite safe to do the double operation simultaneously in children but in adults the temporary rigidity of the parts about the sutured canal results in more strain being thrown upon them by vomiting coughing or post-operative distension *If only one side is dealt with at a time the intact side will* be more elastic and will carry some of the strain and in this way relieve the operated side It appears to the writer that this is reasonable and he has recently adopted the practice of dividing the operation It is logical to allow a sufficient time for consolidation to be completed and the interval should not be less than from 4 to 6 weeks It is important to be assured that no chest complication

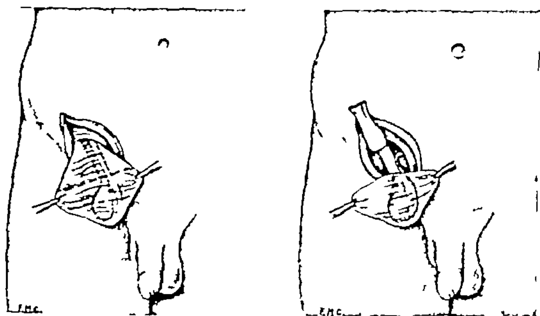


Fig. 486.—Method of isolating sac in congenital hernia. The testicle has been temporarily withdrawn from the scrotum.

has occurred in the interval and this should not be overlooked even after a local anæsthetic.

Operation in children —It is often a help to raise the pelvis with a small sandbag or cushion beneath the buttocks The only special difficulty is to identify and isolate the rather delicate sac The subcutaneous tissue is often so plentiful that an ample incision is necessary to expose the region of the external ring The structures of the cord are often spread out over the sac and great care must be taken not to tear the vas or the vessels If there is difficulty in finding the margin of the sac it is better to incise in a direction parallel with the cord when the sac will eventually be opened and a finger can be introduced into its interior as a help in separation If the sac is of the congenital type it must be divided above the testicle The lower part is left to form a tunica vaginalis but it is not necessary to close it by ligature or suture The upper part is separated high up and ligatured off whilst traction is maintained Even in the hands of

careful operators the sac may somehow disentangle itself from the ligature and its edges widely retract. If the edges cannot be easily grasped for re-ligature or closure by a continuous suture probably no harm will follow provided the edges of the internal ring are approximated by suture Some Continental operators have deliberately recommended that no attempt need be made to ligature the sac in infants.

Hernia with imperfect migration of the testicle—When this condition is encountered before the age of 10 or 12 it is probably best not to interfere surgically as the enlargement of the hernia may encourage descent of the testicle Of course strangulation or attacks of pain or great increase in size would make operation imperative. Should operation be called for the hernia must be dealt with as described After the isolation and removal of the sac it may be possible to mobilize the testicle easily so that it can be placed in the scrotum when it must be dealt with as described in Chapter XLIV When operation for the hernia must be carried out in very young children and the undescended testicle is small and delicate it is probably better merely to deal with the hernia and to leave the testicle in its abnormal position either for a trial of hormone treatment or to be dealt with by operation some time between 12 and 14 years of age if it has not descended naturally in the meantime. When operating great care must be taken not to remove the testicle inadvertently (*loc cit*) with the sac. In older children and adults the radical cure can be combined with the operation for the testicle usually by the Keetley Torek method.

Operations for bubonocele.—In this condition there may be no proper sac merely a general or localized bulging of the peritoneum either external or internal to the deep epigastric artery or on both sides of those vessels It is then only necessary to separate the bulging portion from the muscle-edges and to invert it towards the abdomen closing the canal by suture of the conjoined tendon to Poupart s ligament Of course a bigger sac should be carefully separated and removed the opening being closed by a continuous suture as in closure of the peritoneum in laparotomy When not too tense the external oblique should be overlapped.

Operation in the female.—This must be done carefully and thoroughly for it is wrong to suppose that almost any operation however simple will necessarily lead to a radical cure The external oblique should always be divided over the length of the canal. The sac may be so closely incorporated with the round ligament that it may be very difficult to separate them in these circumstances they may safely be ligatured off together In other cases the sac can readily be identified and separated from the ligament After dealing with the sac the conjoined tendon is sutured to Poupart s ligament superficial to the round ligament and the canal is completely closed

by careful suture of the external oblique When the sac descends into the vulva it is often difficult to separate and there may be a good deal of venous hæmorrhage as a result In such cases it may be safely cut across at the upper part of the vulva leaving the fundus *in situ* the upper part is of course thoroughly separated and ligatured off The part of the sac left behind does not require to be closed it becomes safely obliterated

Sliding hernia or hernia "en glissade"—In this variety the mesentery of the contained bowel is incorporated with the sac so that what would be the posterior wall of the sac is occupied by the extraperitoneal tissue carrying the mesentery with its vessels On the right side such a hernia may contain the cæcum with part of the ascending colon and the termination of the ileum and on the left some part of the sigmoid The separation of the mesentery from the cord is usually a matter of considerable difficulty and involves the risk of injury to mesenteric vessels As a rule the surgeon must be content to remove only a portion of the sac, and the remainder with its contents is then returned as far as possible into the peritoneal cavity or into the extra peritoneal tissues The canal should then be closed in the usual way Quite often the opening in the peritoneum after part of the sac has been removed cannot be ligatured in the ordinary way but must be closed by a continuous suture Fortunately the neck of the sac in this variety of hernia is always wide and there is little risk of strangulation

Unusual contents of the sac.—Except for the appendix any part of the viscera, abdominal or pelvic found in a hernial sac should be returned to the abdomen Every effort should be made to reduce omentum but sometimes it is so diffusely adherent and so much hypertrophied that it cannot be separated or returned to the abdomen In these circumstances it may have to be removed. Great care must be taken in ligaturing off omentum as many serious accidents have occurred from the retraction of large vessels It should be taken up with reliable forceps in small sections and should not be divided too close to the ligatures Catgut should be employed as a sort of chronic inflammation omentitis (epiploitis) has sometimes followed the use of silk.

The appendix in the sac.—If the part of the cæcum from which the appendix arises is also in the sac it is best to remove the appendix The same may be said if the cæcum can easily be drawn down into the sac exposing the base of the appendix No attempt should be made to remove the appendix unless its attachment to the cæcum can be easily and conveniently exposed without pulling and hauling If the appendix is not to be removed care must be taken to avoid damaging it by forceps In the event of removal by this unusual route it is proper to inform the parents or the patient as to what has been done

Meckel's diverticulum in the sac.—This may be found alone when the condition is known as Littré's hernia or with the coil of small intestine from which it arises It is usually free but may be fixed by adhesions the result of previous inflammatory trouble If the patient is on the young side and in good condition the trained competent surgeon will probably decide to excise the encumbrance even if it means intestinal resection with end to-end union. In other circumstances it may safely be returned to the abdomen with little apprehension as to subsequent trouble.

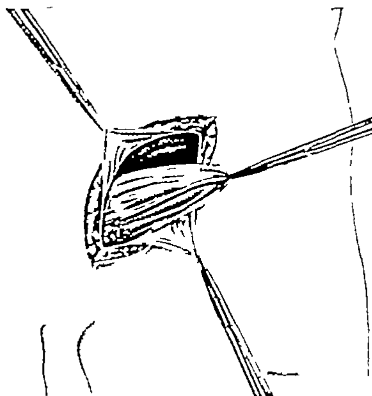


Fig 487 —Bladder in the sac the mass of fat and the bladder fibres may be seen.

The bladder in the sac.—This is most frequently found in direct hernia but it may occur in the oblique variety In either case it is commonest in those who are obese or extremely flabby Very rarely a portion of the peritoneum-covered bladder may be a free content of the sac but much more usually it bears an extraperitoneal relationship to the inner side of the neck and is usually exposed when the latter is being isolated preparatory to ligature It appears as a rounded mass of fat which does not easily separate from the sac. On opening into this fat the muscular fibres of the bladder may be seen. It is a good rule to remember that if the neck of the sac cannot be cleared by gauze-stripping the bladder is probably adherent In such circumstances no attempt should be made to separate the viscus but the ligature should be applied below it If the bladder is inadvertently injured the tear

must be closed by suture. In these circumstances it is better to bring a small rubber drain from the site out of the inner angle of the parietal incision Any resulting external urinary fistula will heal spontaneously but without external drainage peritonitis or extra vasation into the pelvic cellular tissue may prove fatal

Lipomata of the sac.—These tumours are not infrequent though there is usually nothing to indicate their presence before operative exposure They are soft elongated masses of fat with a pedicle attached above the level of the internal ring As a rule they are noticed when clearing the sac and are very easily separated from it and from the cord. They should always be removed either with the sac or after the latter has been dealt with The small leash of vessels which run in the pedicle requires ligature In long-standing hernias fibromata may be found in the sac wall usually near the fundus cysts of various sorts also occur These conditions are of academic interest and will usually be removed with the sac

Injury to the vas.—This may be cut cleanly through or torn or a section may actually be removed. In all but old men the vas should always be repaired. If frayed or irregular the ends must be cut cleanly across so that they can be approximated accurately and held together by a couple of fine catgut stitches passed through the cellular tissue which forms a sheath for the structure Some surgeons advise that a fine stitch on a straight needle should be passed into the lumen of either end for a short distance to ensure that the channel is united end to end.

Injury to the femoral artery or vein.—These vessels have been punctured during the passage of the deep sutures and hæmorrhage or later traumatic aneurysm has sometimes been the result A cutting needle may produce quite an appreciable wound in the vessel wall The accident is immediately followed by the escape of blood which may start from the needle track or rapidly spreads in the cellular tissue The proper treatment is to withdraw the needle at once and to apply firm pressure to the site for about five minutes As a rule this suffices to arrest the hæmorrhage If it does not do so Poupart s ligament must be strongly retracted downwards and the injured vessels exposed by stripping away the cellular tissues The puncture can then be sutured across with a small rounded needle (such as is used for cleft palate) mounted with very fine catgut or silk An additional stitch in the adventitia may be necessary If these methods do not suffice the vessel—usually the external iliac artery—will have to be ligatured above and below the injured site and divided A hole in the vein wall is best occluded by a lateral ligature of fine silk catgut does not take a sufficiently secure bite

Results.—*Mortality* —This is very small and in the hands of trained surgeons is considerably less than 1 per cent Coley and his co-workers *vide infra* had a mortality of only 0 15 per cent in 8 858 operations

Among the causes pulmonary complications including embolism rank high

Recurrence—Coley and Hoguet reporting their results at the Hospital for Ruptured and Crippled New York from January 1891 to January 1918 analysed 6 090 operations* In 5 818 oblique inguinal hernia cases the results were —

	Cases	Recur rences	Per cent
In the male (97 per cent under 15)	4 420	25	0 57
In the female (children)	690	1	0 15
(adults)	869	18	3 5
With undescended testis	334	0	0

The results following types of operation were —

	Cases	Recur rences	Per cent
Bassini	3 725	14	0 38
Cord not transplanted	702	11	1 3

As so many of these cases are children the results are better than could be expected in an adult series Torek† reports 2 recurrences in 600 cases operated upon by his method.

Battle‡ found that 85 per cent of recurrences occurred within twelve months He stated that the three causes of recurrence were—

(1) Incomplete removal of sac.
(2) Advanced condition of secondary weakness in elderly patients.
(3) Trauma or faulty technique

He found that in 107 recurrent cases suppuration had occurred in only 22

Sir Cecil Wakeley§ gave the results of a follow up of 1 140 operations for inguinal hernia which showed a recurrence rate of 5 4 per cent among 851 cases traced. In 1942 Sir Max Page reported a recent follow up of 174 Metropolitan policemen on the question of recurrences. The operations had been done by several different surgeons including some by house surgeons. Two years was taken as a minimum follow up period and every case was examined personally Of 161 cases traced and examined 24 or 14 9 per cent were found to have recurred Considerably lower and also much higher recurrence rates have been reported by British surgeons probably a 5 per cent. recurrence rate represents the average results in a cross-section of inguinal hernia at all ages and of all types in times of peace.‖

The Army problem—In the 1939–45 War recurrences became a serious problem and it was estimated that they amounted to 12 per cent As most were otherwise fit young men between the ages of 20 and 30 the matter became very difficult from a practical and administrative point of view Suggested causes were improper selection for operation faulty technique sepsis and chest complications.

* *Am. Surg* Sept 1918 lxviii, 769
† *Am. Surg* July 1919 lxx, 68
‡ *Lancet*, 1900, ii, 601 § *Lancet*, May 4, 1940, i, 822
‖ The reader should consult "Inguinal Hernia, Critical Review by Brigadier Harold Edwards, *Brit. Journ. Surg* No. 122, 1943 xxxi, 172.

In children recurrence ought to be practically non-existent and in healthy young adults up to 30 it should not be more than 2 per cent but much higher figures must be expected in older patients Sliding hernia has a recurrence rate of about 20 per cent For accurate statistics the cases should be divided into age groups and every case should be examined by a trained observer as sometimes the patient is unaware of an existing recurrence or alleges that such has occurred when non-existent

The results of operations for recurrence are very disappointing and in Wakeley s series (*loc cit*) further recurrence appeared in no less than 38·6 per cent There is no doubt that the best chance of cure lies in a properly executed first intervention

These considerations emphasize the significance of the operation for hernia which must always be classed as one of the most important in surgery It should never be undertaken without great attention to all the details and it is grossly unfair to the patients to hand these operations over to junior surgeons without careful supervision

DIRECT INGUINAL HERNIA

The attempt to cure direct inguinal hernia is of comparatively recent date. The condition is acquired as the result of muscular degeneration of the internal oblique and transversalis while generally the aponeurosis of the external oblique has lost much of its tone In some few cases the sac actually passes through a hole in the conjoined tendon The sac lies to the inner side of the deep epigastric vessels and is not rarely associated with an oblique inguinal sac Often it is nothing more than a bulging of the peritoneum but so relaxed are the structures that the bladder is often found in association with the sac.

The usual Bassini s incision is made and the aponeurosis of the external oblique divided in the direction of its fibres The two flaps are turned back the lower until the upper grooved surface of Poupart s ligament is cleared the upper so as to expose not only the conjoined tendon for a width of an inch but also the sheath of the rectus abdominis in its lower two inches The sac is then cleared and carefully defined and the presence or absence of an associated oblique sac verified. The cord will be found external to (in front of) the sac and is usually easily separated If there is a double sac direct and indirect it may be necessary to ligature and divide the deep epigastric vessels to facilitate exposure of the necks of the sacs and for their ligature It may be possible to lift up the vessels and by passing a pair of pressure forceps behind them to lay hold of the direct sac and withdraw it to the outer side thus converting the two sacs into a conjoint oblique sac It is said that this manœuvre lessens the risk of damage to the urinary bladder it is certainly the best plan when there are two definite sacs

The neck of the sac is often very wide so that it may be impossible to transfix and tie in the ordinary way In such a case it should be opened the contents reduced (they are rarely adherent) and

the edges trimmed so that they may be united by a running suture in the way that the peritoneum is closed after laparotomy The cord is held aside and sutures are applied to close the gap in the musculo-aponeurotic wall It will be found impossible in many cases to form a sufficient barrier by a simple suture of conjoined tendon to Poupart s ligament To supplement this Wölfler in 1892, suggested that the rectus muscle or its sheath should be utilized.

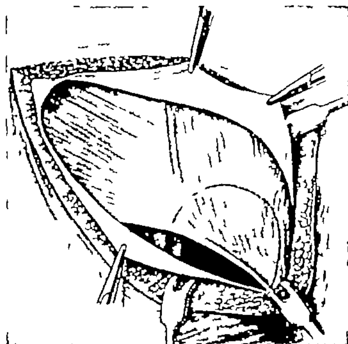


Fig 488 —Radical cure of direct inguinal hernia. Internal oblique aponeurosis exposed and area of flap from rectus sheath marked by dotted line.

(Reproduced by permission of Sir Geoffrey Keynes.)

This may be done in one of three ways (*a*) the lower two inches of the outer border of the rectus muscle in its sheath is sewn down to the inner surface of Poupart s ligament without mobilization (*b*) the rectus sheath is opened the muscle mobilized and the outer edge sutured to the inner surface of Poupart s ligament or (*c*) a flap is made from the anterior layer of the sheath its base at the outer border and this flap is turned down the attached edge acting as a hinge The edge of the flap is sewn to the inner aspect of Poupart s ligament. (Figs 488 489) All these methods have their particular disadvantages Method (*a*) may be impossible owing to the absence of mobilization method (*b*) weakens that part of the abdominal wall which depends on the rectus muscle method (*c*) gives a comparatively inefficient barrier which owing to the weakness of the posterior sheath of the rectus at this point is not very firmly attached at its hinge. My preference is for method (*b*) which gives a substantial barrier with a resulting weakening of the abdominal wall that is more theoretical than actual

Close attention must be paid to the point at which the conjoined ndon meets the outer edge of the rectus When all the sutures are d so as to draw the musculo-aponeurotic structures over the gap hind the cord the aponeurosis of the external oblique is sutured perficial to the cord additional security being obtained especially the aponeurosis is lax by overlapping the inner flap over the outer e free edge of the latter being sutured to the sheath of the rectus

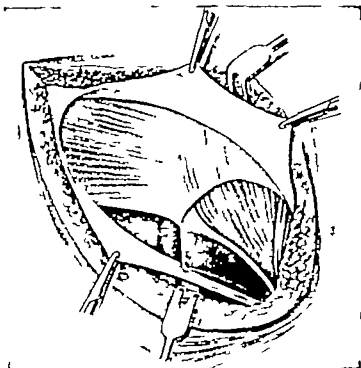


Fig. 489 —Radical cure of direct inguinal hernia. The flap has been reflected and sutured to Poupart s ligament.
(Reproduced by permission of Sir Geoffrey Keynes.)

i its lower part Living sutures of fascia lata (Gallie s method) or rips cut from the edge of the divided external oblique and left attached t one end have been especially useful in direct hernia where the uscles cannot be approximated without tension or where they are articularly weak and friable The strips of fascia are used as sutures or the deeper part of the operation No attempt is made to approxi iate the structures if there is great tension the fascia being used o form a network between the two A second fascial strip is sed to weave the abdominal aponeurosis and the rectus sheath to 'oupart s ligament This suture starts at the internal abdominal ing and ends at the spine of the pubis It is interwoven with the rst to make a sort of mat over this part of the abdominal wall A nore recent *method which is now often employed is to close the gap* vith a lattice suture of floss-silk

Results.—As might be expected the results compare badly with hose of the ordinary Bassini operation for oblique hernia. Downes

and Erdman give 15 to 20 per cent. of failures * and Max Page † in a follow up of operations on London policemen found a recurrence rate of no less than 25 per cent With the alternative methods available such poor results are quite unjustifiable.

FEMORAL HERNIA

This type of hernia may be approached either from above or below Poupart s ligament Until about the last twenty years the lower operation was almost universally employed and proved very satisfactory **Radical cure by the lower route** has undergone no modification for many years. An oblique incision is made over the

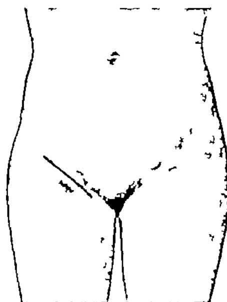


Fig 490. — Oblique incision below Poupart s ligament for femoral hernia.

hernia parallel with and about half an inch below Poupart s ligament. (Fig 490) This gives as good an exposure as the vertical incision sometimes recommended and heals perfectly whereas the vertical scar often becomes thickened and contracted and for a time at least interferes with the free movement of the thigh The incision is deepened until the sac is reached. The superficial epigastric vessels may have to be divided and ligatured and lymph nodes will be encountered but can usually be gently thrust outwards away from the sac. The latter forms a rounded firm mass which is readily identified and can be separated from the cellular tissue in which it lies by sweeping the finger around it The sac must then be opened and the contents dealt with Quite often it contains only some serous fluid which is apparently shut off from the peritoneal cavity Adherent omentum is often a troublesome content and may appear to be incorporated with the sac wall It is essential that it should be

* *Ann. Surg* 1911 [illegible] † *Brit. Med Journ.*, 1934 [illegible]

thoroughly and completely separated and if ligatured off the stump returned to the abdomen Tags must not be left adherent to the neck Having been emptied the sac can be readily isolated up to the crural opening it is usually adherent to the margins of the latter but can be freed by gauze stripping dissecting forceps or a few touches of the knife Having thus been released it must be drawn down so that it may be ligatured off at the highest possible point the

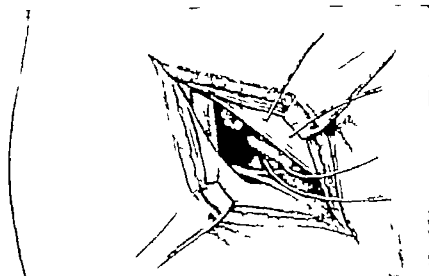


Fig. 491 —Radical cure of right femoral hernia by the lower route. Sutures passed through Poupart s and Cooper s ligaments.

object being to avoid a cul-de-sac which would invite recurrence The surgeon must remember that the bladder may be in relation on the inner side and that the femoral vein is in close relationship to the neck on its outer side If the neck is small it may be transfixed and tied whilst being pulled well down as in inguinal hernia but if it is large and fleshy it should be closed by a continuous suture The sac itself is cut away the division being made well beyond the ligature to avoid the risk of the sac retracting from the embrace of the ligature—what sounds like an impossible contretemps does sometimes occur In either case the stump of the sac is pushed with the finger through the crural opening into the extra peritoneal tissue in the pelvis If the hernia is small and the neck of the sac has been properly exposed ligatured and the stump reduced into the pelvis this may suffice and nothing beyond closure of the skin incision be necessary Certainly it is the most important part of the operation If the femoral opening is large enough to admit the tip of the fore finger then it must be narrowed by inserting one or two sutures between the inner end of Poupart s ligament (inguinal ligament) and Cooper s ligament * It is not enough merely to stitch Poupart s ligament to the pectineal fascia which is a thin friable structure

* Cooper' ligament is the name given to the upper attachment of the fascia of the pectineus which is thickened and strengthened by the reflection of the lacunar ligament (Gimbernat), both structures being merged with the periosteum along the pectineal ridge

The sutures must not be thinner than No 1 chromicized catgut and are passed with a small fully curved round needle on a holder They are most conveniently introduced if the surgeon stands on the opposite side of the patient Having perforated the inner end of Poupart s ligament the needle is made to enter the pelvis just over the brim and its point is gradually lifted until it can be passed under the strong band of fascia running along the pectineal ridge which is known as Cooper s ligament. (Fig 491) It should be felt to scrape on the bone so that the surgeon may be sure it has a sufficiently good hold. It is seldom necessary to use more than two sutures and care must be taken not to perforate or compress the femoral vein. The subcutaneous fat should be tacked to the pectineus to help to obliterate the space previously occupied by the sac. The skin incision is conveniently closed by a subcuticular suture of fine catgut

For hernia up to the size of a hen s egg this operation if properly carried out is most satisfactory though the following objections have been urged against it

(1) It is practically impossible to remove the sac flush with the peritoneum—fortunately perhaps as the bladder is often in close relation with the neck of the sac.

(2) It is difficult if not impossible so to apply sutures that the crural ring is closed.

(3) The obstruction of the femoral canal by sutures is valueless.

(4) In strangulated hernia division of the stricture is not without danger and enterectomy and anastomosis are usually impossible through the incision

Radical cure by the upper or inguinal route (Lotheisen's or Parry's* operation).—In view of the possible disadvantages just set out it is not surprising that attempts were made to cure femoral hernia by approaching the crural ring from above. Though Annandale as long ago as 1876 and Tuffier in 1894 † recommended the inguinal route it is only of recent years that it has been at all generally adopted The approach from above is easy exact clearance and ligation of the neck of the sac are practicable the bladder is not in danger as it can be recognized and easily avoided and the crural ring can be seen and accurately sutured In strangulated hernia the advantages of this route are obvious as Gimbernat s ligament can be divided or stretched under direct vision the sac can be opened at the neck and if the gut is gangrenous it is simple to open the peritoneal cavity further and do what is necessary in the way of resection unimpeded by lack of room The only disadvantage is that it is sometimes difficult to withdraw the sac from the canal because of its size or fixity When the predicament arises then by enlarging the inguinal incision it may be possible to retract the lower skin flap below the level of Poupart s ligament so that the sac can be exposed and separated in the crural canal In a very obese subject

* *Brit Med. Journ.*, Oct. 19, 1901 ii, 1136, Radical Cure of Femoral Hernia, by R. H Parry
† *Rev. de Chir* 1894, xvi, 240.

it may be necessary to make a vertical incision from the centre of the horizontal one downward over the crural canal through skin and subcutaneous tissue in order to expose and separate the sac from below In no circumstances must the surgeon be tempted to divide Poupart s ligament

Originally a curved incision was used with the convexity downwards making a flap over both femoral and inguinal regions but it is now usual to make the same incision as for inguinal hernia The aponeurosis of the external oblique is divided in the direction of its fibres the edges being retracted The conjoined tendon is drawn

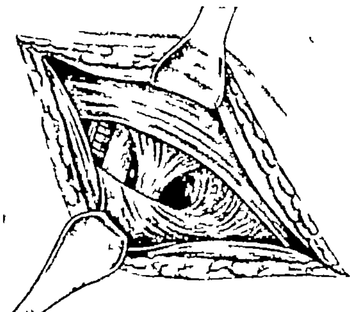


Fig 492 —Radical cure of right femoral hernia by inguinal route neck of sac defined

upwards and the cord or round ligament isolated and looped out of the way The transversalis fascia is divided in the line of the incision up to the deep epigastric vessels but the peritoneum is not opened. All fat and areolar tissue is wiped aside by gauze stripping until the neck of the sac is isolated and the deep epigastric vessels or even the external iliac vein are demonstrated (Fig 492) The sac is now separated from the crural ring—which is plainly seen on retracting Poupart s ligament downwards—and withdrawn from the canal (Fig 493) The sac is opened its contents are reduced and it is then transfixed tied off and cut away as near the general peritoneum as possible The ends of the suture are left long and are threaded on a needle which is passed from within outwards through the conjoined tendon a separate bite of the latter is taken of the tendon with one end of the suture which is then tied on the outer surface under cover of the upper flap of the external oblique aponeurosis The next step is to close the crural ring This can be brought immediately under inspection by retracting the lower flap of the aponeurosis of the external oblique including Poupart s ligament The ring is bounded on the inner

side by Gimbernat s ligament on the outer side by the femoral (external iliac) vein in front by the deep fibres of Poupart s ligament and behind by Cooper s ligament and the iliopectineal ridge The closure is effected by two or three interrupted sutures which must take a good hold of the inner end of Poupart s and Cooper s ligaments. *The number of sutures is determined by the size of the crural opening* but as a rule two or three at a distance of three-eighths of an inch apart will suffice The sutures are passed with a small rounded needle

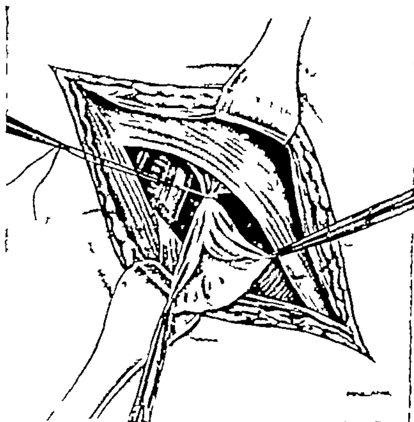


Fig. 493.—Radical cure of right femoral hernia by inguinal route sac withdrawn from femoral canal and neck ligatured.

mounted on a holder Care must be taken not to compress the vein which is readily seen (Fig 494)

In the original method the conjoined tendon is now sutured to Cooper s ligament the first suture also taking a hold of the edge of Gimbernat s ligament. The operation is completed as for inguinal *hernia. When the parts are widely separated or when the conjoined* tendon will not draw down without tension a flap may be cut from the sheath of the rectus and turned down as suggested by Keynes. (Figs. 488 489) In most cases it will suffice to complete the operation by suturing the conjoined tendon to the upper aspect of Poupart s ligament just as in the radical cure of inguinal hernia taking the same precautions as to direction of insertion and degree of tension

when knotting The aponeurosis of the external oblique is united by a series of interrupted sutures and the incision closed (Fig 495) This operation is straightforward but rather more complicated than that by the lower route

Several other operations for this type of hernia have been devised but they do not seem to possess any outstanding superiority Those methods in which Poupart s ligament is divided or detached are to be avoided

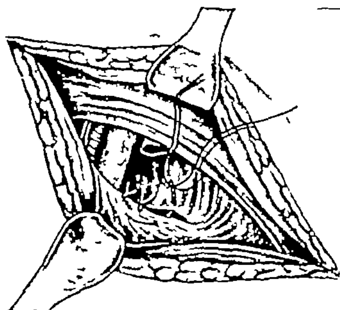


Fig. 494 —Radical cure of right femoral hernia closing femoral ring sac ligatured and retracted under conjoined tendon.

Results.—The end results of both methods are satisfactory and with the exception of the very large hernias or cases complicated by strangulation there are few recurrences In 585 cases Wakeley (*loc cit*) found a recurrence rate of 4 6 per cent In 120 cases of the lower operation Butters found 4 recurrences a rate of 3 3 per cent *

The midline extra-peritoneal approach for groin hernias.—This method which was described by A K Henry † was suggested by the ease with which the femoral ring could be seen during the extra peritoneal exposure of the ureter It was subsequently noticed that the route was almost equally convenient for some of the inguinal hernias and that both the femoral ring and the internal inguinal ring could be easily and securely closed from their abdominal aspect The method has the advantage that the funnel-shaped process of peritoneum superior to the neck of the sac can be readily isolated and removed with the sac A K Henry has found the plan particularly useful for bilateral hernias or for combined inguinal and femoral hernia

Technique —The patient lies on the back with both trunk and thighs slightly flexed to relax the lower abdomen The Trendelenburg

* *Brit Med Journ* Oct 23 1948 p 743
† *Lancet*, 1936 i, 531

position may be a great advantage. A midline incision is made extending from the umbilicus to the pubes This reaches the extra peritoneal tissue but the peritoneal cavity itself is not opened By blunt dissection with the finger commencing below and laterally the peritoneum is readily separated from the muscles in an outward and upward direction until the abdominal aspect of the hernial region is exposed The peritoneum as it approaches the hernial canal appears as a funnel-shaped process leading to the sac which can be

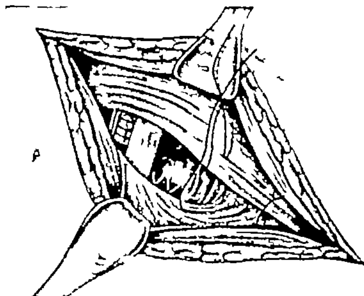


Fig 495 —Radical cure of right femoral hernia closing inguinal canal, conjoined tendon sutured to upper surface of Poupart s ligament.

readily isolated with the finger and drawn up into the abdomen. If as happens in some cases usually inguinal hernia the sac cannot be so readily drawn into the abdomen its upper part may be isolated and after emptying may be cut across below the neck the fundus being left *in situ* in the scrotum After free mobilization the sac is either ligatured off well above the neck and removed or is cut away at its origin the resulting aperture in the peritoneum being closed by a purse-string suture. In femoral hernia the mouth of the femoral canal can then be closed by turning up a flap from the fascia covering the pectineus and suturing it to the hinder edge of Poupart s ligament In inguinal hernia the internal ring is closed by two or three interrupted sutures drawing together the deep surface of its boundaries from above downwards thus narrowing the ring down to the point where it transmits the cord The method is not suitable for large irreducible or strangulated hernias but in other cases the after results have been very satisfactory

UMBILICAL HERNIA

The common type of umbilical hernia is that met with in the adult female between about 85 and 50 years of age it also occurs in the male

but very much less frequently The protrusion takes place about rather than through the umbilical cicatrix so that these hernias are sometimes spoken of as para umbilical but this is a point of no practical significance What is much more important is that in many cases the beginning of the hernia has persisted from infancy and has become steadily larger as the result of child bearing and obesity In the umbilical hernia of adults the fibrous structures of the midline are much stretched by the wide separation of the recti As a consequence the interval between the muscles may be two or three inches and this space is occupied by a strong sheet of fibrous tissue to the inner aspect of which the peritoneum is closely adherent The neck of the hernia is represented by a circular aperture in this tissue with edges which are well-defined and sharp The sac itself is closely adherent to the over lying skin and its interior is often divided into loculi by strong fibrous septa The usual contents are some portion of both large and small intestine together with great omentum In the very large hernias most of the abdominal viscera may be in the sac The colon and omentum are commonly diffusely adherent to the sac but there may also be general adhesions fixing coils of small intestine to one another and to the wall of the sac. It is also quite usual to find adhesions around the abdominal margins of the hernial orifice. The hernia may be of great size and as the patient is generally fat it is really larger than it appears to be so much of the sac being hidden in the subcu taneous tissues which are often several inches deep (Fig 496) Operation is attended by danger not only of failure to secure a radical cure but also to life for a large proportion of these patients are poor surgical risks in many ways However there is so great a tendency to strangulation and the mortality of this complication in umbilical hernia is so heavy that a radical cure should always be attempted if the general condition of the patient does not imperatively forbid it This statement is strikingly illustrated by the results in a series of my own cases up to 1924 The operative mortality in 103 non-strang ulated cases was only 0 97 per cent. whereas in 86 operated upon for the relief of strangulation the death rate was 86 11 per cent

Almost the only absolute contra indication is a hernia so large that the abdominal cavity either cannot accommodate the contents or can only do so at the expense of serious respiratory embarrassment from the crowding of the viscera up under the diaphragm. In view of the frequency and high mortality of strangulation diabetes chronic cough and increasing obesity are to be regarded as indications for preparatory treatment rather than contra indications to operation

Preliminary treatment — Consideration of the causes of death after operations in this type of hernia emphasizes the necessity for careful and perhaps prolonged preparation. Many of these patients are subject to bronchitis with emphysema and fatty dilated heart The anæsthetic may light up a quiescent bronchitis and the return of the massive contents of a hernia into an abdominal cavity which has

perhaps for years been relieved by the safety valve action of the additional accommodation provided by the hernial sac throws a great strain on the already weakened heart Many patients also have glycosuria, renal insufficiency and high arterial tension. The question of preparation must be carefully considered and a routine investigation made special attention being paid to the condition of the heart and circulation and the renal function

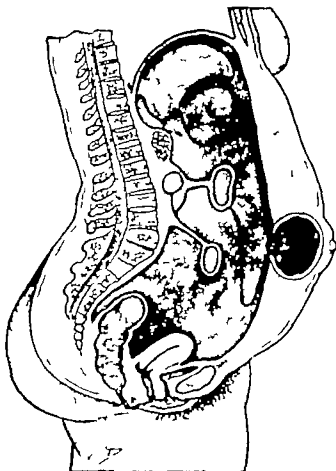


Fig. 496 —Shows sac of umbilical hernia buried in fat of abdominal wall.
(By permission of Sir Geoffrey Keynes.)

Operation should be deferred until the conditions just mentioned have been investigated and efficiently treated

Great attention must be given to the bowels which should be freely moved and if necessary thoroughly cleared out by enemata from time to time While all flatulent foods should be excluded from the diet the strength and general stamina of the patient must not be allowed to suffer from too strict a dietetic regimen Whenever the kidney function is inhibited the patient is given large quantities of dilute cream-of tartar solution, and the intake and output are recorded Operation must not be undertaken until the kidney function reaches a safe level and remains there Many of these subjects

have led sedentary lives and are greatly benefited by regular walking exercises but others are hard working housewives and for them a week or two in bed may be the best preparation A course of medicinal treatment with nux vomica digitalis and ammonium carbonate is very valuable Chronic chest infections may be benefited by appropriate antibiotics

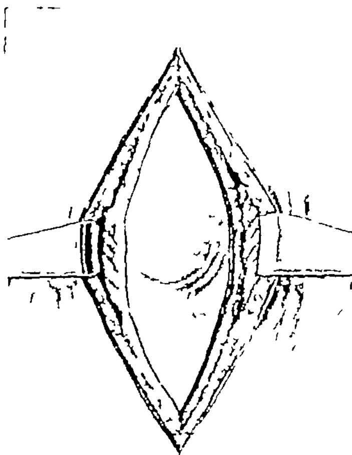


Fig 497 —Radical cure of umbilical hernia by anatomical reconstruction Incision deepened.

The preparation of the skin is important for there is often a moist crease below the hernia which is apt to be infected. In the larger hernias the skin over the summit is not infrequently ulcerated. A few days delay until these parts can be got into good condition will be well-spent time

Choice of operation.—There are many plans by which the principles for the radical cure of hernia can be applied to the umbilical variety The important consideration to bear in mind is that for the closure of the defect in the parietes the aim must be to get the parts together and to hold them without tension until natural healing can occur Very small hernias can often be repaired by a couple of superimposed

purse-string sutures reconstituting the umbilical cicatrix In hernias not more than about two inches in diameter the opening will not be larger than will admit the thumb and the sac can be removed and the abdominal wall reconstructed vertically in the middle line When larger than this the gap through the parietes will probably easily admit 3 or 4 fingers with such an opening the abdominal wall cannot be reconstructed and no attempt must be made to separate the margins of the opening into its constituent layers The conjoined structure surrounding the opening is very strong and will hold sutures but when separated into layers these are thin and friable. If the margins can be turned in vertically or overlapped horizontally (Mayo s method) without tension either of these methods may be employed otherwise such large hernias are only suitable for repair by Gallie s living-suture method, a floss-silk darn or the use of a filigree In actual practice the Mayo method is the most generally useful and satisfactory though of course when it can be done without any tension the reconstruction method is ideal.

Choice of anæsthetic.—This question is important Acute or chronic chest infections and strangulation with regurgitant vomiting are indications for local or spinal anæsthesia. The local infiltration method is quite satisfactory but an unusually large amount of solution may be required and the intervention may take a long time When not contra indicated general narcosis by the gas-oxygen-ether sequence with or without the use of curare is very satisfactory

The reconstruction operation.—An elliptical incision is made either vertical or transverse (Figs. 497–504) to enclose a large area of skin covering the sac. The surgeon is apt to remove too little but it is essential in any case to remove all the pendulous portion Any redundant skin can be removed before the skin closure. To provide a sufficient exposure the ends of the incision must be prolonged well beyond the ellipse The incisions are deepened (Fig 497) until the aponeurosis is reached and then by dissecting the fat carefully off this structure towards the neck of the sac the edges of the hernial opening can be defined

The unopened sac with its cap of skin now stands like an island separated from the fat of the abdominal integument by a considerable interval. At this stage it may be possible to decide whether the recti muscles are too widely separated to be sutured. If they can be drawn together without tension the ideal operation should be proceeded with A vertical incision is made in the middle line above the upper margin of the hernial orifice at the point if possible where the separation of the recti begins This incision is through the linea alba only the peritoneum being so far unopened When the incision approaches the upper margin of the hernial orifice it divides to enclose the protruding sac the incision being still kept in the aponeurosis but quite close to the margin of the hernial orifice. At the lower margin the right and left incisions join again and the midline incision is prolonged

downwards till a point is reached where the recti muscles once more approach each other The peritoneum is then separated from the rectus sheath until it is possible to lift up the unopened sac with its contents

The next step is to incise the neck of the sac to open it and to deal with the contents (Fig 498) Lifting up the sac with its omental stalk and aponeurotic fringe at the neck a space is found where the

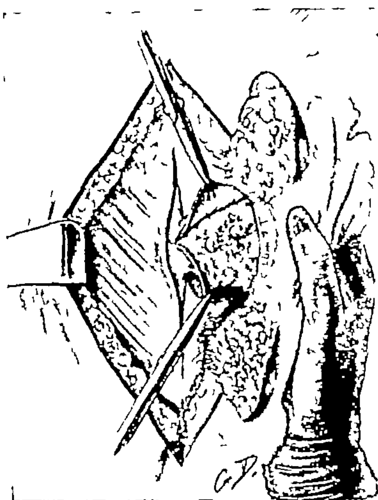


Fig 498 —Radical cure of umbilical hernia by method of reconstruction opening sac.

finger can be passed from below into the sac between the omentum and the neck. However adherent the contents are to the sac wall it is rare to fail to find an interval At this point the neck of the sac with its aponeurotic fringe is cut at right angles with scissors and the opening enlarged The sac is gradually turned inside out the adherent contents being peeled off its interior or separated by snicks of the scissors till all is free

Method of dealing with the contents.—As a rule the sac contains a large quantity of omentum together with large and it may be small intestine Some part of any of the viscera except the pancreas may

be found in very large hernias The transverse colon with its attached omentum is the most usual content and is often diffusely adherent to the anterior wall of the sac In long-standing cases and especially in those in which there have been repeated attacks of strangulation there are often many adhesions between the loops of intestine the other contents of the hernia and the wall of the sac. It is necessary to deal with these contents very deliberately and carefully As already described, the sac must be opened at the neck and the operator must then enlarge the

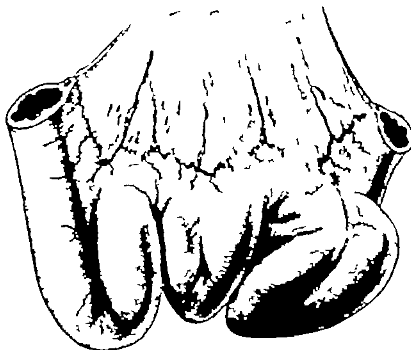


Fig. 499 —Kinked and adherent gut as frequently met with in cases of umbilical hernia.

opening with scissors guided by the finger as to the direction in which the wall can be most safely incised. In this way the sac is gradually completely opened up and the contents dealt with systematically As far as possible adherent omentum should be separated and returned into the abdomen for it provides a useful covering for the intestines and may be very valuable in the event of subsequent inflammatory disturbance When large masses have become hypertrophied, they may require removal but great care must be taken in ligaturing them off Any big adhesions must be carefully caught in clips or ligatured before being divided as they may contain vessels which are apt to retract and may account for alarming or even fatal hæmorrhage. Smaller and more diffuse adhesions are not usually so vascular and this is one of the few operations in surgery in which apparent roughness may conduce to efficiency for when the diffusely adherent omentum is torn away from the sac wall there is often much less bleeding than if it is divided with scissors or scalpel. Adhesions of the bowel to the

sac are more difficult to deal with and sometimes it is wise to cut away a portion of the sac and leave it attached to the intestine with which it is returned into the abdomen In dealing with a large hernia and especially in cases where there have been repeated attacks of previous trouble it may be a lengthy business so far to disentangle the contents that they can be safely returned but it is essential that it should be done thoroughly and without undue haste Sometimes

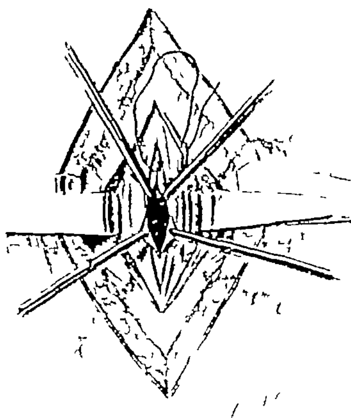


Fig 500 —Radical cure of umbilical hernia by method of reconstruction sac removed. Suturing of peritoneum.

the adhesions between the coils of intestine lying inside the sac appear as if they would invite subsequent obstruction though the involved gut may easily be returned into the abdomen without separating them (Fig 499) In this state of affairs the surgeon must use his discretion and be guided by the circumstances as to whether it is safe and wise to disentangle such adhesions or whether the gut must be returned adherent and the risk taken If there are evident signs of obstruction or if this complication appears likely to supervene either a lateral anastomosis should be made or the affected mass excised In the latter event end to-end anastomosis is best Occasionally an inflamed appendix is found in the sac and there may even be an abscess In these circumstances the appendix ought to be removed and the abscess cavity emptied and dried as far as possible and the parts

returned into the abdomen In any case after the contents have been dealt with and returned the remains of the sac must be cut away leaving a sufficient margin for suture.

The peritoneum throughout the length of the incision is now closed by continuous suture. (Fig 500)

Beginning at the upper end of the incision in the aponeurosis the surgeon opens the rectus sheath on both sides if this has not already been done in exposing the sac and identifies the edge of the muscle.

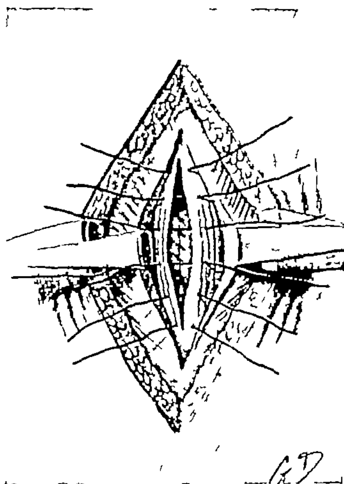


Fig. 501 —Radical cure of umbilical hernia suture of rectus abdominis.

This is continued throughout the length of the incision until the inner edges of both recti are free the anterior layer of the sheath being dissected back for a short distance The recti are now drawn together by interrupted catgut sutures passed so as to include the edge of the muscle and the posterior layer of the sheath Great care must be taken not to make these sutures too tight or they cut through the muscle in their grasp (Fig 501) A series of silkworm-gut sutures is now passed from side to side at intervals of 2 in through the skin and fatty integument taking in the anterior layer of the sheath and the rectus muscle. These sutures are introduced at this stage

so that the surgeon can assure himself that they included all but the peritoneum at a later stage they are tied over the gauze dressing after the skin has been sewn and serve to obliterate dead spaces The greatest care is taken to arrest all bleeding for hæmorrhage between the suture layers is a common cause of failure in these operations

The anterior layer of the sheath of the rectus is now closed either by simple suture (Fig 502) or by overlapping if this structure is sufficiently

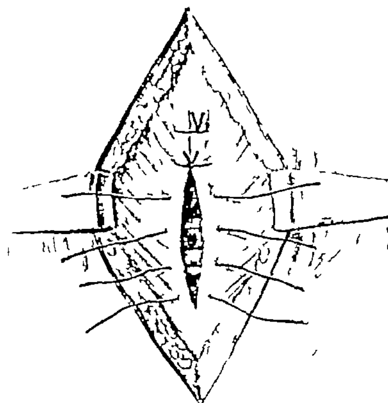


Fig. 502 —Radical cure of umbilical hernia closing aponeurosis.

lax A series of interrupted sutures unites the skin edge and if need be drainage is provided

The vertical overlapping method —When the recti are widely separated and the sheet of aponeurosis which unites them is sufficiently lax it may be turned in by a series of mattress-sutures as shown in Fig 503 without any attempt being made at layer suture This plan was advocated and frequently used by Rutherford Morison and yielded very satisfactory results

Simple transverse overlapping operation (Mayo method) —This plan is that usually chosen where the recti are so widely separated or so

adherent to its contents and is turned inside out so as to peel the adherent contents off its wall The remarks on p 1271 about the method of dealing with the hernial contents apply

In hernias of moderate size it may be possible to close the peritoneal neck of the sac by suture but in the bigger hernias this is impossible not only because of the size of the aperture but because the peritoneum is so closely adherent to what is really the greatly widened linea alba

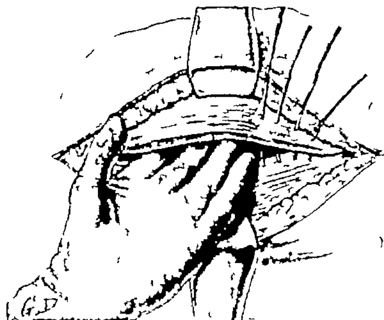


Fig. 506.—Radical cure of umbilical hernia by overlapping insertion of sutures.

that it cannot be treated as a separate structure In these circum stances the peritoneal cavity is closed by the overlap The upper flap of aponeurosis *with the peritoneum* is made to overlap the lower * The needle armed with thick chromic catgut No 5 is passed from without inwards through the upper flap one or two inches above its margin the suture must then take a good hold of the lower flap and be made to emerge through the upper flap ½ in from where it entered (Fig 506) A series of these sutures is applied at intervals of ½ in the lower flap is drawn under the upper and the sutures are tied From 3 to 5 of these mattress-sutures will usually suffice. This step should close the peritoneal cavity effectually but the upper flap must be turned upwards and any gaps between the sutures through which tags of omentum could escape must be closed by an independent stitch here and there The peritoneum on the under surface of this upper flap is scored in various directions to promote more ready adhesion when it is applied to the lower flap It is then turned down to lie on the lower flap and its free edge is sewn to the upper surface of the lower flap by a continuous catgut suture or a

* On rare occasions it will be found that the lower flap will overlap the upper more comfortably and with better apposition.

series of interrupted sutures (Fig 507) Interrupted silkworm gut sutures are inserted as in the last operation to obliterate dead spaces all bleeding is controlled the skin sewn up and an anchored dressing fixed by tying the silkworm-gut sutures over the gauze When the wound is very large or as so often happens the subcutaneous fat is deep and difficult to approximate accurately it is wise to provide for drainage (*a*) to diminish the risk of hæmatoma and (*b*) to allow the escape of broken down fat The drainage should be by rubber tube of little finger size brought from a small independent incision

The dressing of these cases must be completed before the patient recovers from the anæsthetic because the strength of the diaphragm is so great that its sudden action may easily tear away the suturing

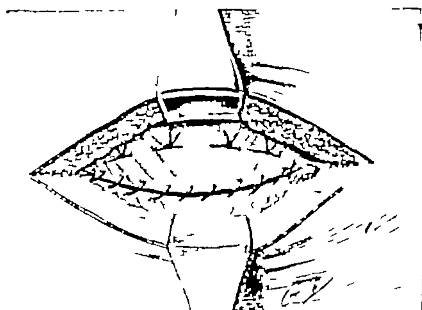


Fig 507 —Radical cure of umbilical hernia by overlapping sutures tied. The sutures for the edge of the fascial flap are usually interrupted.

unless firmly supported After the application of the gauze and wool the dressing must be fixed by a many tailed bandage of ample size On the outside of the bandage long strips of sticking plaster should be applied from one flank right over to the other both directly transverse and obliquely

After treatment.—Certain points in the after treatment deserve special attention These patients often have considerable respiratory embarrassment partly because of their bulk and the tendency to bronchitis and sometimes because of the increased intra abdominal tension from the reduction of the hernia. It is most important that this should not be made worse by abdominal distension For this reason any *epigastric discomfort indicates the stomach tube—not for* lavage but simply to empty the viscus of gas and mucus This measure often gives great relief It is also important to be sure that the patient is not only passing urine but is emptying the bladder and in bulky

subjects this can only be ascertained by the use of the catheter Gas in the intestines should not be allowed to accumulate and it is wise to pass a flatus tube systematically every 4 or 6 hours If in spite of these measures abdominal distension persists it should be treated by repeated small doses of strychnine gr $\frac{1}{60}$ every four hours and the occasional use of pituitary extract. A simple glycerine enema will often result in the passage of a large volume of flatus The same object may be assisted by inhalation of 90 per cent oxygen which may be continued for 12 hours



Fig. 508 Healthy child at 4 years of age who was born with evisceration of the abdominal contents, including the liver

The organs were replaced and the abdominal wall repaired half an hour after birth The patient was alive and well with only slight residual herniation at the age of 19.

The infantile type.—The umbilical hernia of infants may sometimes be cured by keeping the protrusion *continuously* reduced for three months by a pad fixed with adhesive Unless such a pad keeps the hernia effectively reduced it is quite useless After two years of age this method is most unlikely to be successful and since the condition is often the forerunner of the troublesome adult hernia radical cure is recommended

Operation —In order that the child may not be conspicuously different from its playfellows the umbilical cicatrix should be preserved For that purpose a curved incision is made either by its side or below it and a small flap is turned aside with the scar exposing the underlying sac In this step the sac may be opened but this is of no moment. The sac is isolated its neck exposed and ligatured and the sac removed The aperture in the parietes may sometimes be closed by a purse-string suture or its edges merely drawn together or it may be overlapped as in the Mayo method. Any plan which closes the gap seems to be efficient in children. The skin flap is then turned back into position and carefully sutured. The child may be allowed up and about as soon as sound healing has taken place

Exomphalos or amniotic hernia.—In this condition there is arrest of intra uterine development and the intestines are not withdrawn into the abdomen The large hernia like protrusion has for covering immature tissue without proper blood supply If this condition does not rapidly retrogress soon after birth operation should be carried out

without delay The membrane forming the summit must be excised but every particle of skin should be preserved and the incision surrounding the swelling must closely follow the skin margin Some of the abdominal contents will be adherent to the inner surface of the sac but can usually be safely separated by the finger assisted by gauze stripping The skin edges are turned back to a sufficient extent to expose the aponeurosis of the abdominal wall The edges of the gap are then approximated by interrupted sutures of stout catgut as there is usually considerable tension A series of silkworm gut sutures is also passed through the skin and the deeper parietes These are run through fine rubber tubes to diminish the risk of cutting into the skin Some few intermediate stitches draw the skin edges into accurate apposition Further to diminish the considerable tension the wound is supported by strips of Elastoplast The tension silkworm sutures are not removed until after 10 or 14 days By that time they may be nearly buried in the tissues and it may be necessary to administer an anæsthetic to aid their removal. Although the condition is a serious one several cases successfully treated by operation are on record *

General results of operations for umbilical hernia.—Unlike inguinal and femoral hernias where the mortality of the radical cure is very small there is an appreciable risk to life in umbilical herniotomies even in non-strangulated cases This is due to the fact that the patients are generally unsuitable from the surgical standpoint often being subject to bronchitis or renal insufficiency with dilated heart and high arterial tension McGlannan reports an immediate mortality of 8 per cent increased in strangulated cases to nearly 50 per cent The St Bartholomew s Hospital figures for the six years 1910–15 report 79 cases with one death increased to 16 deaths in 31 strangulated cases (about 50 per cent) To the end of 1928 Grey Turner had 121 radical cures with 2 deaths a mortality of 1 65 per cent. but in 36 strangulated cases there were 13 deaths a mortality of 36 11 per cent

Figures of any value cannot be given for recurrences owing to the different methods employed and the varying conditions found at operation. Mayo reports 75 cases treated by his method with 1 partial recurrence Coley and Hoguet† report 334 cases in adults with no recurrences Such a degree of success is contrary to general experience and the surgeon naturally looks for some explanation. Sufferers from this variety of hernia are often so stout that a considerable recurrence may be so completely concealed in the subcutaneous fat that the patient may be unaware of it Unless such patients are examined by an experienced person recurrences may be undetected In an un selected series personally operated upon mostly by the Mayo method and examined by myself I found 38 per cent of recurrences In 57 cases Wakeley had 22 2 per cent recurrence

* Lambert Rogers, *Brit Journ Surg* N 113, 1941 xxix, 37 Lev *ibid* N 118 1942, xx 168
† *Ann. Surg.*, 1918, lxvii, 263 G F Burrell, *Person. Comm* 1950. R W Smith Da, *Lancet* 1953, ii, 431.

OBTURATOR HERNIA

This hernia though very rare occurs with sufficient frequency to justify a short description of its peculiarities and the technique of treatment. In the majority of cases it is only discovered when laparotomy has been carried out for intestinal obstruction The local signs are indefinite and may be absent altogether In a well marked case there should be a swelling which may be only a diffuse fullness in the upper adductor region to the inner side of the femoral vessels. There may be tenderness on pressure over the upper and inner parts of Scarpa s triangle and if the pain radiates to the knee (Romberg s sign) the picture is complete but it is unusual to meet such a combination of signs. The patients are usually elderly wasted women who present symptoms and signs of small intestinal obstruction without any feature to indicate the cause.

Anatomy—Three varieties are described (1) The usual type *where the sac occupies the obturator canal in front of and to the* inner side of the obturator artery and nerve and lying on the obturator externus muscle covered by the pectineus (2) The hernia separates the fibres of the external obturator muscle so that it lies under cover of the pectineus with a muscular collar round the neck of the sac. (3) It separates the layers of the obturator membrane burrowing from above downwards so that it is covered not only by the pectineus but also by the obturator externus

It must be remembered that the position of the obturator artery is *not constant and that there is always some risk of hæmorrhage in* freeing the neck of the sac

Operation through Scarpa's triangle.—The Trendelenburg position may be advantageous The thigh is flexed and abducted A vertical incision of adequate length is made parallel with and at least 1 in to the inner side of the femoral vessels beginning just below the spine of the pubis The interval between the adductor longus on the inner side and the pectineus on the outer side is sought and the muscles are separated and well retracted. A thorough retraction of the pectineus aided if necessary by cutting some part of the muscle will expose the sac The neck should be thoroughly cleared and the exact position of the obturator vessels ascertained. The edge of the constricting ring is defined and an attempt made to stretch rather than to incise it The sac is then opened care being taken to catch any fluid that may be present for fear of infecting this deep wound The contents are now reduced if the hernia is strangulated the loop is drawn down and the site of constriction scrutinized. If any treatment of the intestine is necessary it is best at this stage to open the abdomen with the patient in the high Trendelenburg position to withdraw the loop of intestine and to do what is required outside the abdomen. The attempt to close the opening is more likely to be successful from within and is free from risk of injury to the vessels. If the hernia

is not strangulated or if the gut can safely be returned the sac after being emptied is transfixed tied and cut off as high up as possible It is doubtful whether the closure of the canal can be achieved but the deeper part of the wound should be obliterated with catgut sutures and drainage provided

Operation through the abdomen.—As a rule this hernia is only discovered incidentally during the course of operation for intestinal obstruction in thin elderly women In these circumstances the small intestine will be found apparently attached to the pelvic wall just below the front part of the brim Inspection which is easier in the Trendelenburg posture will reveal the true condition As a rule slight traction on the bowel will be enough to withdraw it into the abdomen but occasionally it may be necessary to stretch or to incise the neck of the sac before the bowel can be released. Incision of the neck should be made directly forwards The bowel must be dealt with as its condition indicates (*see* p 1278) After the intestine has been released and dealt with the sac may be withdrawn into the abdomen and ligatured off This may be done by passing a strong artery forceps to the bottom of the sac seizing a portion and with drawing it through the neck i.e inverting the sac into the peritoneal cavity (This is a method which may be employed for femoral or even small inguinal hernias when they are discovered during the course of an abdominal operation) If this is not possible the orifice must be closed by a purse-string or other type of suture

Epigastric hernia—This variety is usually quite small and often turns out to be an extra peritoneal lipoma herniated through an aperture in the linea alba. To make a satisfactory repair it is best to incise the aponeurosis in the middle line up to the edges of the apparent sac both above and below it The sac is carefully isolated and should always be opened before ligature as it may contain omentum or very rarely a knuckle of stomach or colon The contents are seldom adherent The sac is excised and the parietes repaired in layers In this hernia the circumstances often demand an exploration of the upper abdomen and this may conveniently be combined with the repair Quite often an undetected carcinoma of the stomach has accounted for the symptoms attributed to the presence of the hernia.

SCAR OR INCISIONAL HERNIA

The following are amongst the commonest causes of this type of hernia —(1) prolonged drainage of an intra abdominal abscess (2) suppuration of an abdominal incision with retraction of the edges and healing by granulation (3) separation in the muscle-layer suture-line (4) injury to the muscles or their nerve supply (5) incessant cough and (6) persistent abdominal distension after operation The first cause is by far the most common and may well be considered together with the second since it is almost the rule for suppuration of the wound to occur if prolonged drainage is necessary Occasionally a

weak scar is seen as the result of stitch abscesses It sometimes follows cholecystostomy when the gall bladder has been drained for a long time or suprapubic prostatectomy or colostomy although in neither of these cases does suppuration of the abdominal wall usually occur

Scar hernias of the third group are by no means well understood. It is recognized that from time to time cases occur where for some unknown reason there is a spontaneous bursting open of the wound sometimes the whole incision giving way with intestinal protrusion but more usually the peritoneal and muscle suture-lines give way first and the skin subsequently In some cases the skin does not give way and a scar hernia quietly establishes itself

In the fourth group the rectus abdominis is generally affected, the nerve supply being injured by long incisions in the linea semilunaris or in muscle-splitting operations as in some vertical approaches to the gall bladder through the rectus muscle

Prolonged drainage of an intra abdominal abscess is often accom panied by sloughing of some structures of the abdominal wall aponeurotic or muscular or both The chances of a scar hernia are in direct proportion to the length of time that drainage is maintained Thus Abel states that two weeks drainage is followed by scar hernia in 40 per cent three weeks in 60 per cent four weeks in 65 per cent and over four weeks in 80 per cent He also maintains that a scar hernia is twice as likely to follow single-layer suturing as multiple-layer suturing

Characters of a scar hernia.—With the exception of those cases in the third and fourth groups where suppuration has not occurred *the scar always shows evidence of slow healing It is irregular* wide puckered and perhaps discoloured The covering is thin generally consisting of atrophied skin without fat or superficial fascia The edges of the main opening in the abdominal wall can be defined but there are often small subsidiary hernias in the line of the scar with stretching and weakness of the areas between. Frequently the hernia can apparently be easily reduced or even reduces itself when the patient lies down Many such hernias are more or less irreducible, for there are adhesions between some part of the contents and the sac or the peritoneum at or near the neck of the sac There is also always some loss of substance in the abdominal wall generally aponeurotic sometimes muscular The hernia always contains omentum generally large intestine and sometimes small intestine There is a resemblance between scar hernia and umbilical hernia in that many of these patients are fat and are poor surgical risks so that it is advisable to prepare them for operation very much on the same lines.

Technique of repair —No trivial intervention will suffice and the whole of the scar in the skin must be widely excised by an elliptical incision which is deepened until the aponeurosis is reached this must be carefully cleared of fat the dissection proceeding towards

the margin of the hernial opening until the edge is identified If the opening is a small one and there has been no great loss of tissue an anatomical restoration of the abdominal wall should be attempted *A spindle-shaped incision is made through the aponeurosis the ellipse* skirting the opening as closely as possible and the ends being prolonged as far each way as may be necessary A free incision of the aponeurosis makes the subsequent steps all the easier This incision is deepened at a point farthest away from the hernial opening and the peritoneal cavity opened as there is less risk of adherent viscera at the periphery The peritoneum is opened in the line of the incision the unopened sac is lifted up and the general peritoneal cavity packed off with pads around the pedicle The sac is opened at the neck and emptied by blunt dissection being turned inside out if necessary to facilitate the freeing of adhesions The sac is then cut away the pads are removed the hernial contents replaced in the abdomen and the peritoneum sutured.

The aponeurosis is now dissected back for a sufficient distance to expose the muscle-layer What the muscle-layer may be depends on the situation of the hernia for instance it may be the rectus muscle on the inner side and the internal oblique on the outer side in appendix cases (following Battle s incision) or the recti abdominis in epigastric cases The whole of the muscular boundary of the aperture must be exposed and if the edges are attenuated into a sheet of fibrous tissue this must be cut away until the muscular fibres are exposed. All bleeding is arrested and the muscle sutured with interrupted catgut sutures The aponeurotic layer is now stitched edge to edge or preferably overlapped and the skin sutured usually without drainage

A different method should be adopted if the opening is very large or if there has been much loss of tissue or if the edges cannot be approximated without tension In such circumstances the attempt to effect an anatomical restoration of the abdominal wall will almost certainly be a failure and it is much better not to try

The steps are the same as those of the preceding operation up to the point where the hernial contents are replaced in the abdomen No attempt is made to separate the abdominal wall into layers. If the peritoneum can be separated it should be carefully sutured but most often it has to be included with the other tissues It may then be possible to overlap the sheet of fibrous tissue which forms the margin of the opening This is carried out in much the same way as in the Mayo method for umbilical hernia or by the method associated with the name of Rutherford Morison (Fig 508) Some surgeons consider that the fibrous tissue which has replaced the muscles will not form a reliable barrier and prefer to cut it away until normal looking muscle is reached When this has been done it may leave a very large defect and it may be impossible to get the freshened muscle edges together In these circumstances it is necessary to approximate them as nearly as possible with stout catgut sutures and then to bridge any resulting gap with fascial strips or floss-silk

crossed after the fashion of a shoe lace. When this is accomplished an attempt must be made to get the external oblique into apposition supporting the catgut sutures with fascial strips or floss-silk. Sometimes a free patch cut from the fascia lata may be used to cover a large aperture with rigid edges that cannot be approximated, but this method has not proved very reliable.

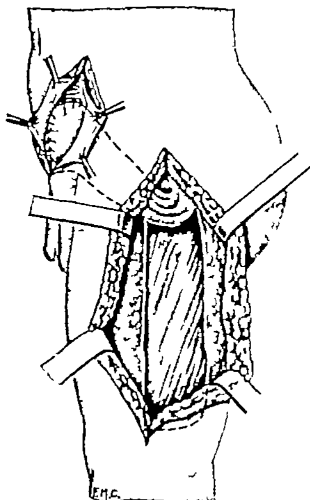


Fig 509.—Repair of recurrent inguinal hernia by transplantation of tensor fasciæ femoris muscle.

When the edges cannot be approximated two other plans are available. One is to use a silver wire filigree, the other is to swing in a large muscle flap The filigree is laid on the muscle edges and fixed with a few points of suture the external oblique being drawn together over it as far as possible the subcutaneous tissue as well as the skin being carefully approximated.

The use of muscle as a flap has most often been employed for hernia situated in the lower lateral part of the abdominal wall In the upper abdomen pedicled flaps of fascia and muscle have been turned down from the pectoral region Kenneth Mackenzie has used this plan

with success.* A patient presented a very large traumatic hernia in the lower abdomen and the tensor fasciæ femoris seemed to be the most suitable muscle because: Its upper attachment to the spine of the ilium is of small size and this allows of the easy swinging of the muscle. The nervous and vascular supply enter the muscle very high up and nerve and vessels placed near the centre of swinging are scarcely stretched when the muscle is in its new position. Lastly, the loss of this muscle is of small account to the limb. After the sac of the hernia has been dealt with, a vertical incision is made down the

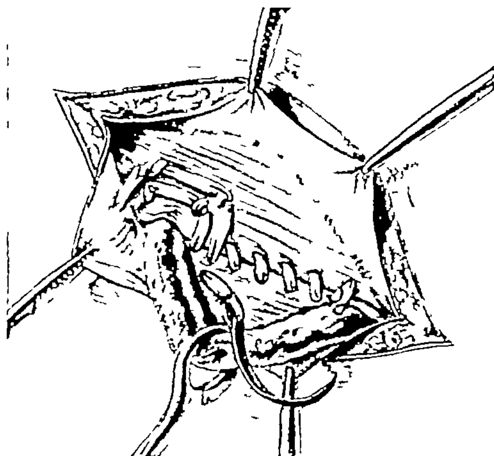


Fig. 510.—The repair of recurrent inguinal hernia by Gallie's method. The first layer.

antero-lateral border of the thigh so that the whole of the tensor muscle is exposed. The origin of the muscle from the ilium is left intact but the fascia lata is divided about 1½ in. all round the muscle so that the latter is supplied with a fascial fringe. After being thoroughly freed in the thigh it is swung round into the gap in the parietes. The margins of fascia surrounding the muscle may overlap the margins of the gap or may just fit into it (Fig. 509). In either case they are to be fixed to the margins of the hernial opening with catgut or fascial sutures and the skin and subcutaneous tissues are carefully sutured over all. The details of the method are also discussed and fully illustrated in a paper by Owen H. Wangensteen.†

* Brit. Journ. Surg. 1924, xii, N. 45, 28.

† Surg. Gyn. Obstet. Nov. 1934, lix, 764.

This surgeon has also employed the method in certain cases of inguinal and femoral hernia and with encouraging results In all operations of this type great care must be taken to arrest all hæmorrhage and to protect the large wound from risk of infection Interventions for large scar hernias rank among the biggest in surgery and may be attended with considerable shock and patients must be carefully watched and cared for during the ordeal

Operations for recurrent inguinal hernia.—The surgeon must *exercise great care in exposing the parts as the anatomy is so much altered by the previous attempts at repair* When the veins of the

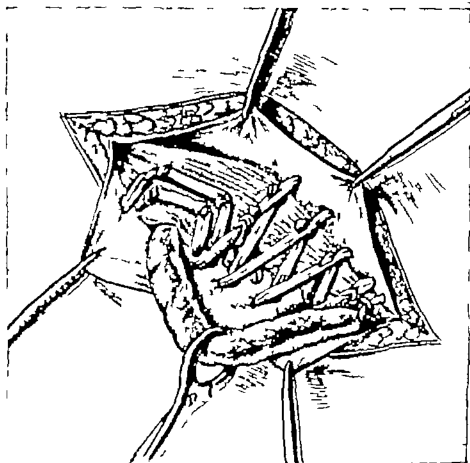


Fig 511 —Gallie s operation completed by interlacing fascial sutures.

cord have been removed at the first operation the difficulties are increased In these circumstances what remains of the cord is often in jeopardy and the vas may easily be torn or divided No rules can be given to make this operation easy but it is essential to have a sufficient exposure and to endeavour at an early stage to identify some anatomical structure which will serve as a guide * It is in dealing with these cases that Gallie s method of repair (*Figs 510 511*) *is so valuable*

* William P Tuck *Brit. Journ Surg* No 123, 1944, xxxi, 231

Those who have experience of floss silk assert that it may be used instead of fascial strips In femoral and the different varieties of ventral hernia there are not such special difficulties but the sac may be deviated and loculated and the structures bounding the openings to be closed are often very attenuated The surgeon must constantly bear in mind the importance of adequate exposure by ample incisions which need not necessarily follow those originally employed

Lumbar Hernia

This usually follows an operation for exposure of the kidney though it may be congenital and through Petit s triangle For radical cure it is first essential to expose the sac with its boundaries As a rule such a sac should be carefully isolated and removed but a shallow (not very large or prominent) sac may be inverted towards the abdomen without being opened. The sac may contain the descending colon which may be extensively adherent to its wall and much care must be exercised lest it be torn The boundaries of the hernial aperture will be the muscles of the area and these if they have not been too much damaged by suppuration may be defined and sutured layer by layer with stout catgut The most superficial of the muscles may be like a sheet of scar tissue and in that case may often be overlapped Whenever there is tension fascial sutures should be used in addition to catgut But in some cases either the whole of the involved area or some part of it has firm resisting edges which cannot be drawn together In these circumstances the gap must either be closed by interlacing it with fascial strands or floss-silk or by using a filigree

Suprapubic Hernia

This variety either follows drainage of the pelvis by the abdominal route or suprapubic cystotomy It may be possible to deal with it on the general principles already described but when the lower margin is formed by the pubic bones it is difficult to make a satisfactory closure in this way In the latter circumstances Nuttall* has suggested that the recti muscles should be divided just above the pubes or detached from that bone and should then be crossed over the hernial site (of course after excision of the sac) and sutured in this new position (Fig 512) In his hands the later results have been satisfactory

Incisional Hernia in Different Sites

In the iliac regions where it may follow operations for appendicitis or resection of the colon or closure of colostomy the condition can usually be dealt with satisfactorily The whole of the original incision must be opened up and time and patience expended in defining the hernial margins and in removing the whole sac. If the appendix has not already been removed this should be done In the smaller

* *Brit. Journ. Surg* 1937 No. 96, xxv 344.

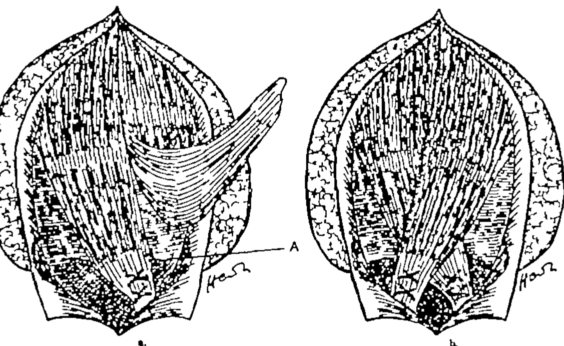


Fig. 512 —Crossing the recti for cure of suprapubic hernia (a) Right rectus. (b) Left rectus sutured to pubes of opposite side (A) upper edge of symphysis pubis.
(Reproduced by permission of H. C. W Nuttall and the *British Journal of Surgery*.)

hernias in patients not obese layer reconstruction is usually possible but in the larger varieties the overlapping method is nearly always required. The parts to be apposed must be free from fat and must be closely applied to one another i e. there must be no dead spaces in which blood might accumulate In the epigastrium whether in the middle line or over the rectus repair by reconstruction is usually feasible and satisfactory When following oblique subcostal incisions as for gallstones or splenectomy repair is not easy Reconstruction should be the aim but some part of the repaired area may have to be supported by fascial strips or floss-silk used either as sutures or to make a lattice for it is quite useless to try to drag the parts together if there is great tension. Subumbilical hernia can nearly always be dealt with by a thorough reconstruction which should be the aim but if not feasible the method of Rutherford Morison (p 1275) may be satisfactory Suprapubic hernia or those following renal operations are dealt with at p 1289

Very Large Hernias

Inguinal herniæ which reach almost to the level of the knees are seldom seen nowadays but there are some few examples of very large ruptures which are often recurrences following operations for inguinal hernia or are of the incisional type In such cases the question usually arises as to the wisdom of attempting any operation and each case must be decided on its merits One of the first questions is the capacity of the abdominal cavity to contain the added contents of the hernia

without embarrassment to respiration and general comfort When the abdomen is naturally lax and the hernia readily reducible the question is easily answered but in other circumstances the surgeon must make an estimate of the probability A hernia which appears to be irreducible will often recede when the patient is kept in the Trendelenburg posture for a day or two or complete reduction may then be brought about by manipulation If the patient is comfortable after reduction and is neither short of breath nor the abdomen

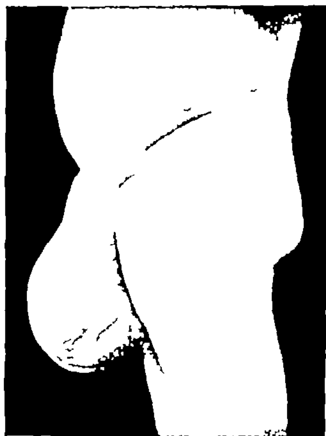


Fig 513.—Large inguinal hernia.

unusually tense the conditions for operation are favourable Even in cases of strangulation these considerations play a part in the management of the case. If for instance it seems impossible for the abdomen to contain the contents of the hernia with comfort then the surgeon must be content to open the sac deal with the obstructing or strangulating agent and merely repair the sac without attempting either to reduce the contents into the abdomen or to carry out radical cure

Where there is no strangulation the general condition of the patient must be carefully looked over before interference and especially the questions of glycosuria and renal function Chronic cough and increasing uncontrollable obesity are both very serious drawbacks to successful intervention Naturally the state of the cardiovascular system is very important but a high blood pressure is not in itself a contra indication to operation

When it has been decided to operate some little time must be devoted to preparation In many of these patients the mere size of the hernia has seriously interfered with their getting about and careful regulated walking exercise is a valuable preparation Regulation of the diet to diminish gaseous distension and the care of the bowels are both important Free bowel movements must be secured. Careful preparation of the skin is also essential and one or two days are often required for its thorough cleansing The question of anæsthesia deserves consideration but as fascial strips have often to be cut the choice will usually lie between spinal or inhalation anæsthesia

In the actual operation the first step must always be the proper exposure isolation and removal of the sac and this will require a large parietal incision The closure of the abdominal wall may be unexpectedly easy and catgut sutures may secure good apposition without tension But difficulties in closure are frequently met and it is then that the fascial sutures of Gallie or the floss-silk lattice are so useful In those few cases where the gap is so large that the strips make but a feeble lattice work over the huge aperture or where fascial sutures have not been a success in a previous operation at least two other methods may be resorted to (a) the wire filigree (p 1288) and (b) muscle transplantation (p 1289) In elderly men with poor muscles and a wide floor to the canal it may be justifiable to eliminate the embarrassment of the cord by castration or by simply dividing the cord between ligatures. In either case the upper ligatured end must be placed in the cellular tissue of the pelvis so that the abdominal wall may be completely closed

In these operations it is essential that asepsis and hæmostasis should be faultless but this is often difficult because of the extent of the wound and the time occupied in the operation These interventions may severely tax not only the resource but also the patience of the surgeon and some technical laxity may creep in during the later stages During the operation it is wise to take great care to cover with large gauze swabs such part of the wound as is not actually required at the moment. In the after-care the prophylactic use of penicillin which is now usual very much diminishes the risks of chest complications as well as wound infections but abdominal distension must also be carefully avoided or promptly treated

American surgeons have tackled the problem of the enormous umbilical or ventral hernia by actually excising large amounts of the parietal tissues with the sac and if necessary the whole of the omentum and the greater part of the colon While not often required these plans are certainly justifiable in these days of safer surgery when a crippling hernia interfering with usefulness and enjoyment may otherwise prove incurable

STRANGULATED HERNIA

It should be recognized that anything wrong with a hernia usually demands operative interference which is far safer than the old

temporizing measures which were adopted when surgeons diagnosed conditions like incarceration and inflammation rather than strangulation The surgeon may find that a hernia has been reduced *en masse* by attempts at taxis and this may be done by the patient himself auto-reduction *en masse* In conditions of doubt exploration of the hernia is much safer than any other plan The mortality of strangulation runs high but it is never too late to operate and many an apparently moribund patient unexpectedly recovers after minimal intervention

Anæsthesia —In the presence of vomiting all hernias of moderate size should certainly be operated upon under local infiltration anæsthesia. In large hernias and especially the umbilical variety local anæsthesia may occupy a great deal of time but the greater part of the operation can often be completed under this method only a small quantity of general anæsthetic being necessary in the later stages If the blood pressure is not much lowered spinal anæsthesia can safely be employed but has largely been superseded since the use of curare as an adjunct to general anæsthesia Whenever a general anæsthetic must be employed in the presence of active vomiting the stomach should be emptied by tube immediately before as there is very grave risk that intestinal contents may be regurgitated during the operation and may be aspirated into the lungs For this reason it is a good plan to leave the tube *in situ* while the operation is in progress so that the stomach can be aspirated from time to time The steps of the operation for strangulated hernia are always the same (1) parietal incision and exposure of the sac (2) opening the sac (3) inspection of the contents (4) dealing with the stricture or strangulating agent (5) disposal of the contents and (6) completion of the operation

In inguinal and femoral hernias *the strangulating agent* is nearly always the peritoneal neck of the sac and this can usually be drawn down sufficiently to be divided either with scissors or hernia knife under the guidance of the eye In femoral hernia Gimbernat s ligament may be a contributory factor in strangulation but should not be hastily divided as this step weakens the hernial region very much After the sac has been opened forceps are applied to its cut margin and with a little care and the aid of dissecting forceps the parts outside the neck can nearly always be loosened sufficiently to enable the sac to be drawn down so that the neck can be seen and divided under the guidance of the eye as in inguinal hernia. Sometimes it is impossible to pull down a femoral sac in this way In these circumstances the surgeon should introduce a finger into the sac and reaching the strangulating agent with its tip will often find that he can gradually insinuate the finger through the neck by the side of the intestine and can dilate the orifice sufficiently to break down its resistance completely and enable the gut to be easily drawn down for inspection If neither of these methods is possible then it is necessary to divide the

neck of the sac blindly This is done by introducing a hernia direc between the bowel and the neck on the inner side A hernia knife then carried up the groove of the director and the neck of the : divided. If this is done it will nearly always be found that the co striction disappears and that it is unnecessary to divide Gimberna ligament but in some cases this must be incised before reduction c be effected. It should be cut from outside and not through the s In umbilical hernia the strangulation may either be at the neck of t sac or inside the sac some of the contents being caught in a pocl or being strangulated by bands or adhesions In these circumstan it is easier to see the exact cause but it may be difficult to disentan the parts and to free the contents completely

The management of the gut.—The intensity of the dark colo *of strangulated gut is not taken alone a criterion of bad progno* while pulsation not necessarily seen but felt in the mesenteric vess is a good sign Offensive smell and the presence of yellow lymph the surface of the bowel are ominous Gut that has not lost lustre and tone as shown by the way it retains its shape and whi begins to improve in colour as soon as ever the constriction is reliev will probably recover completely When there is doubt the surge must first satisfy himself that the strangulation is completely reliev and must then apply moist warmth to the bowel and wait for seve minutes. Change in colour from a dark dusky hue towards a brig red is the best sign and especially if accompanied by a return pulsation in the vessels and peristalsis Rapid improvement in colc during the inhalation of oxygen is a good omen

When it has been thought safe to return the gut the operati can usually be completed by carrying out the radical cure suital for the region involved In old and very feeble subjects or when t surgeon is working under improvised conditions or is inexperienc the question will arise how to deal with the sac and finish t *operation without proceeding to the formal radical cure* In these c cumstances the tyro need have no hesitation in leaving the sac *in si* and simply packing it and the wound with gauze. This is the simple method of finishing the operation and is all that is necessary f life-saving purposes Any further interference for the radical cure the hernia can be deferred to a later date weeks or months after t operation or in fact in old and enfeebled people and especially wi *femoral or small inguinal hernias may often be dispensed* wi altogether as the hernial region will heal by granulation and possib not give much further trouble Some cases of strangulated umbilic hernia are so enormous that it is courting disaster to attempt radic cure after strangulation has been relieved and it is much wiser mere to stitch up the hernial sac and to leave it *in situ* without any attem at its removal i.e to restore the hernia to its original state aft dealing with the strangulation. Many a life would be spared if th step was adopted. Surgeons should recognize that the life-savin

measure is the operation of hemiotomy which does not presuppose the performance of radical cure in addition

Doubtful gut —In many cases of femoral hernia in feeble people the gut is extensively damaged though not obviously beyond recovery In these circumstances it may be reduced just within the hernial opening a tube being brought to the surface through the incision The gut very rapidly becomes adherent in its new site and quite often a case recovers without any complication or with the formation of only a temporary fæcal fistula No rules can be given which will decide when this method should be adopted or when it is necessary to resect or make a formal fæcal fistula. Probably one method is as successful as the other but with either the mortality is not less than 50 per cent

When the hernial sac contains only a small knuckle of intestine (Richter s hernia) it is absolutely essential that the bowel should be brought down into the sac for thorough inspection Sometimes the little button which has been nipped is obviously quite recoverable but in many cases it is of doubtful vitality In the latter circumstances it may be of such a small size that it can safely be inverted into the intestine and over-sewn by the Lembert method It is only when it involves an area greater than one-third of the circumference of the bowel that in doubtful cases a formal resection should be carried out

It is in these cases that the gut often slips back into the abdomen before it can be pulled down As it is safer to inspect the gut than to leave the matter to chance the surgeon should enlarge the orifice of the sac and draw down the intestine for careful examination The intestine which has occupied the sac remains in the vicinity of its abdominal orifice for some time and can nearly always be grasped with a pair of sponge forceps and brought down so that any doubtful areas can be dealt with. If this is not done then in a certain proportion of cases the gut will subsequently give way in the abdomen and the patient will die of rapid peritonitis after being apparently completely relieved by the operation

Gangrene of gut —In some cases of strangulation it is found on opening the sac either that the gut is gangrenous or that its vitality is so doubtful that its return to the abdomen is inadvisable. The whole loop may be gangrenous including the mesentery or there may be patches of gangrene chiefly on the antimesenteric border or gangrene may have occurred only at the line of constriction This last possibility makes it essential after the constriction is divided and before the gut is reduced to draw the loop down so that the line of constriction can be inspected. (Fig 514) The appearance of a gangrenous piece of intestine—the flaccid collapsed loop with its lustreless discoloured (black grey or green) surface the pulseless mesentery and the sanious blood-stained and perhaps offensive fluid in the sac—is sufficiently characteristic to make error unlikely But in the lesser degrees of strangulation it is difficult at times to be

In some cases it will be found that the upper (proximal) end is so much larger in diameter than the lower (distal) end that end to-end anastomosis seems unsuitable. Much may be done however by an oblique section of the lower end to increase its lumen or an incision may be made along the antimesenteric border at right angles to the open end of the smaller bowel. Generally speaking it is safe to pucker up the larger end by placing the stitches more widely apart than in the smaller end in cases where the disproportion is not too marked The alternative is to close both ends and do a lateral anastomosis but this is rarely necessary End to-side anastomosis is not advised

(8) **Making an artificial anus.**—In the more desperate cases where the condition of the patient not only forbids a long operation but when decompression of the intestine is imperative the formation of an artificial anus is indicated *In all cases the constriction must be relieved* as a first step and the loop drawn down so that the line of constriction can be inspected This obviates the risk of perforation and extravasation within the abdomen or inside the neck of the sac as the result of ulceration at the stricture line The simplest method of all is to attach the loop by a few sutures to the sac as near the neck as possible incise the gut along its antimesenteric border sew the cut edge to the sac or the skin at the line of incision and make certain of adequate drainage by passing into the proximal loop a tube of the size of a 14 rubber catheter If however a considerable length is gang renous this method would leave a mass of septic material which would take a long time to separate and might well give rise to infection of the surrounding integument In such a case it is well as a first step to suture the two limbs of the loop together above the portion to be resected and also to the sac near the neck to prevent the loop slipping back into the abdomen The gangrenous portion is then cut away and all bleeding carefully arrested. When speed is of prime importance the gangrenous gut may be simply cut away irrespective of its size. The ends may then be anchored to the sac or sides of the incision and either left open or tubes tied in.

After treatment of artificial anus.—This presents many problems. In the first instance as the result of toxæmic paresis of the intestine the bowels may not function. In these circumstances the general remedies which are most valuable are first those relied upon for overcoming toxæmia and especially flushing the tissues with saline or tap water administered by the rectum or glucose saline injected intravenously Secondly the stimulation of the plain muscle of the intestine by hypodermic exhibition of strychnine in small doses frequently repeated and by the use of specific excitants such as pituitary extract or acetylcholine or similar substances. The inhalation of 90 per cent oxygen is sometimes effective If these measures all fail purgative remedies may be tried and of these the best is calomel in quarter-grain doses repeated every half hour until 3 grs has been administered assisted by the other measures which have been

mentioned Strong concentrated salines are also sometimes effective Injections may be made locally into the exposed lumen of the bowel and various substances may be tried

The next difficulty is the too-free escape of intestinal contents especially when the opening happens to be high in the alimentary canal. In these circumstances it may be possible to conduct the contents from one loop to the other by a rubber tube inserted temporarily or the escaping contents may be collected and injected into the lower loop by a syringe or may even be administered per rectum The fluid and chloride loss may be temporarily renewed by the intravenous administration of normal saline When the problem becomes serious and despite all efforts the patient begins to lose ground then some surgical interference is imperative In these circumstances the simplest measures which will suffice should be first adopted As a rule it is necessary to open the abdomen well away from the site and to make an anastomosis between the loops of bowel going to the hernia Such an anastomosis will probably not function satisfactorily unless the bowel between it and the hernia is interrupted either by division and inversion of the ends or by a thick encircling ligature of catgut buried by a few Lembert sutures Once the normal intestinal current is restored the patient may be expected to pick up rapidly and the operation for the repair of the hernia and the removal of the gut in that situation can be undertaken with confidence in three or four weeks In other cases in which the whole of the contents do not escape by the fistula spontaneous closure may take place or the fistula may be dealt with locally at the hernial site This requires the separation of the intestines from the margins of the opening so that they can be drawn down for the purpose of repair Quite often a formal resection may be necessary and in femoral hernia this is better conducted through an independent laparotomy incision about two inches above and parallel with Poupart s ligament

After the resection the isolated bowel in the sac with its pouting open ends may be removed by working from the abdomen and the hernial site or it may be left *in situ* for a still later intervention In this event the open ends in the abdomen must be closed by suture before the abdominal incision is dealt with. If the patient is in very poor condition time may be saved by tying tubes into the open ends and bringing them from the abdominal incision The next operation can then be safely deferred until a convenient time probably some weeks later the patient being allowed up and about meanwhile. As a result of this sequestration the gut in the sac may shrivel in a remarkable way until it eventually appears as one or two small mucous fistulæ in the midst of the scar at the hernial site

Neglected strangulated hernia —These are nearly always small femoral hernias in which for several days the local condition has unaccountably been overlooked. There are two common types in the first the patient is desperately ill perhaps moribund but there is no sign of inflammatory trouble about the small unobtrusive hernia.

Using local anæsthesia the sac is to be opened and the constriction freely relieved but nothing further is done the incision being left freely open lightly packed with gauze. If the gut slips back when the constriction is dealt with a piece of soft rubber tube is placed in the femoral opening and gauze packed loosely around it In the second type the patient is generally not so ill but the hernia is inflamed and may look like an abscess ready to burst An incision is made into the mass and the sac opened but nothing further is done Complete relief may follow either at once or after the spontaneous formation of a fæcal fistula. If despite the incision the obstructive symptoms continue the abdomen should be opened above Poupart s ligament and a lateral anastomosis made between the limbs of the bowel loops entering and leaving the hernia.

After-care.—The general management must be conducted on the same lines as in intestinal obstruction in general Unless there has been very serious toxic damage natural improvement usually commences as soon as the strangulation is relieved. Cessation of vomiting and movement of the bowels are the best signs of recovery Deprivation of fluid and nourishment must be made up and if this can be done by the natural channels so much the better but the intravenous route may be required. If recovery is slow in commencing the use of both *the stomach tube and the rectal tube is likely to be helpful* Warmth to the abdomen the inhalation of 95 per cent oxygen small hypodermic doses of strychnine gr $\frac{1}{60}$ repeated every 4 to 6 hours divided doses of calomel gr $\frac{1}{4}$ every half hour up to 8 grs pituitary or physostigmin and the use of glycerine enemata (1 or 2 drachms) may all be very useful The remarks on meteorism on pp 1149-52 Vol I may also be consulted. The surgeon must never forget Nature s sweet restorer gentle sleep or the therapeutic use of stimulants especially in those patients accustomed to them To avoid or limit the frequent chest complications and to diminish the risks of venous stasis movement in bed of the limbs and change of position or getting the patient out of bed into a chair at the end of 24 or 48 hours are also valuable preventative measures The systematic use of penicillin may also help in this respect.

Severe diarrhœa is not uncommon within 48 hours of the release of strangulated bowel and the patient must be guarded against the risk of sudden depletion Opium and astringents are of little value in the acute phase but have a place if the condition becomes chronic.

Mortality is still high and Butters in 1948 found it to be 18 8 per cent in a series of 45 cases.* Douglas in 1942 (*loc cit*) recorded 16 5 per cent Analysis of these figures showed the mortality in the various groups as—inguinal 8 per cent femoral 17 6 per cent and ventral 27 7 per cent The mortality rose progressively with the duration of symptoms before operation

Accidents and sequelæ in connection with the operation for strangulated hernia—Sometimes the neck of the sac has been torn during

* *Brit Med Journ* Oct 23, 1948, p 743

attempts at reduction or more commonly it has been rather too freely incised during division of the constriction In either case the *intestine may be reduced inadvertently* through the rent into the cellular tissue strangulation then persisting as the result of constriction by the margins of the rent It is only necessary to mention this possibility to show *the necessity of care to prevent it* A continuous gradation of pathological changes may follow strangulation of a loop of bowel in a hernial sac * and this may occur whether the reduction is by *taxis* or operation. One of these conditions may be a physiological stricture taking the form of ileus which may prove fatal This type supervenes within a few days of the relief of strangulation This is to be treated by measures already detailed sometimes this condition has yielded to spinal anæsthesia. If all means fail to relieve the abdomen must be opened and a lateral anastomosis made short-circuiting the portion of bowel that has been in the sac but it does not follow that even this will be successful for the complication is a very serious one Sometimes an actual fibrous stricture develops eventually producing an ordinary mechanical obstruction This type usually declares itself a few weeks after the strangulation. Raw had 8 cases in all in a personal series of 185 operations for strangulated hernia.

DIAPHRAGMATIC HERNIA

This variety of hernia though not common is less rare than is generally supposed It consists of a protrusion into the chest of some abdominal viscus in part or as a whole and either with or without a peritoneal sac When a sac is absent the contents may be adherent to the thoracic viscera The condition may be traumatic or congenital. In the former variety the defect is generally in the dome of the diaphragm and has often followed war injuries The contents are variable but usually consist of portions of the stomach and colon sometimes with coils of small intestine In one of the congenital types the herniation takes place through the œsophageal foramen and is spoken of as para-œsophageal or hiatal hernia. This variety is sometimes associated with congenitally short œsophagus In hiatal hernia some part of the stomach or even the whole viscus herniates into the thorax and may be accompanied by the left lobe of the liver

The symptoms are usually digestive pain associated with a sense of extreme distension aggravated by food and relieved by eructations or vomiting or change of position Patients sometimes state that they are afraid to eat Quite often gall-stones are simulated and in a good many of the cases the biliary tract has been explored before the correct diagnosis is made In some cases there is *œsophageal obstruction* which may closely simulate cardiospasm In another group cardiac disease of the coronary type has been suspected

* Stanley Raw *Lancet* April 10 1934

Indications for operation.—Diaphragmatic hernia is not in itself an indication for operative treatment as intervention is certainly not free from risk When symptoms are troublesome and persistent operation may be recommended. It is advisable to interfere during the quiescent period and not to risk the development of an emergency When X ray investigation demonstrates small intestine in the hernia *operation should be urged for strangulation is then likely to occur and is a very serious complication*

Technique of operation.—General anæsthesia is usually employed for complete relaxation is essential In cases of difficulty regional may be combined with general anæsthesia by injecting the lower intercostal nerves on the left side just below the angles of the ribs. Complete relaxation of the diaphragm may be secured by blocking or crushing the phrenic nerve in the root of the neck.

The approach largely depends on the type and situation of the hernia and whether the contents are known to be reducible. It is either a question of a high laparotomy or a low thoracotomy In practice the abdominal route is usually employed and in most cases operation can be completed from below the diaphragm A mid line epigastric incision is most useful, but it should be carried right up into the sterno-costal angle. Some surgeons prefer an incision parallel with and just below the left costal margin The reversed Trendelen burg posture is helpful and further exposure may be obtained by separating the left lobe of the liver from its diaphragmatic attachment and drawing it towards the right side (Fig 516) If the aperture can be readily exposed the contents may be withdrawn into the abdomen without difficulty In some cases however reduction may be very troublesome and this may be due to negative pressure or to adhesions. The former may be overcome by introducing a tube into the hernial sac by the side of the contents or by puncturing the pleura. There may be adhesions to the margins of the opening in the dia phragm in which case they can be readily dealt with under the guidance of the eye or the contents may be adherent within the sac or in the absence of a sac to the pleura the pericardium or the lung The surgeon must never be tempted to use strong traction from the abdomen as serious damage may be done to the thoracic viscera. If gentle traction and mobilization with the finger do not succeed in releasing the contents it will be necessary to open the chest freely by an incision along the eighth rib or adjoining interspace so that the adhesions may be dealt with under the guidance of the eye During the process of reduction from the abdomen the sac may be inverted into the peritoneal cavity and may be cut away It is not essential *to make any great effort to remove the sac* as it seems to look after itself but of course if it is not removed the neck must be completely cut across before closure of the defect in the diaphragm

Once the contents have been withdrawn an attempt must be made to close the aperture in the diaphragm and this can usually be accom plished successfully The freshened margins can sometimes be drawn

together without difficulty and may prove so lax that they can be overlapped. Interrupted sutures of stout chromicized catgut should be used for the closure which can often be reinforced by applying the mobilized left lobe of the liver to the sutured area. To anchor the liver in position the two ends of the last suture of closure are left long and are passed on a needle through the left lobe about an inch

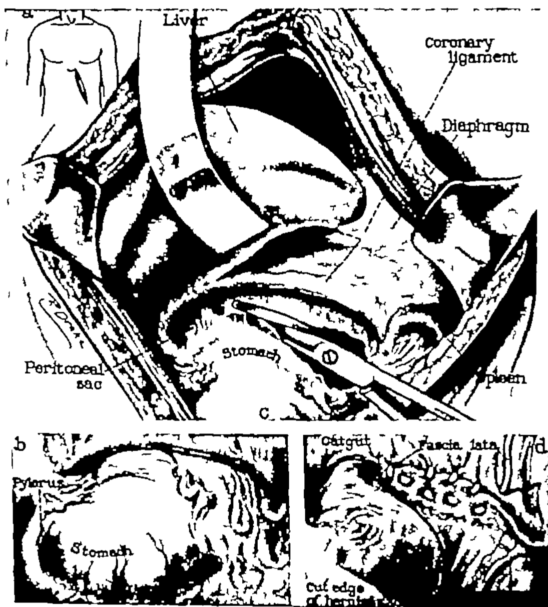


Fig 515.—The abdominal operation for diaphragmatic hernia.
Reproduced from Christopher's *Textbook of Surgery* (U.S.A.) by permission of Dr Stuart W Harrington and W B. Saunders Co.

apart and are then tied in order to apply the liver firmly to the under surface of the diaphragm over the suture line. If the margins of the aperture in the diaphragm cannot be drawn together because of tension the gap may be entirely covered by applying the liver

to its under surface or the aperture may first have to be laced over with fascial strands cut from the thigh or with floss-silk. Whenever there is tension or difficulty in getting the margins into apposition, the catgut sutures ought to be supplemented by fascial strips. Sometimes it is much less difficult to close the hernial orifice from the thoracic surface of the diaphragm than from below The upper approach is described in Vol I p 1006

In strangulation the patients are frequently so ill that the least possible interference must suffice and if the condition can be relieved by opening the abdomen and withdrawing the intestine from the hernia into the peritoneal cavity the radical cure may have to be left until another time There is however great risk of recurrence of this complication and the repair should not be too long delayed.

Sometimes the stomach has been so long in the chest cavity and is so much distended that there does not seem room for it in the abdomen In these circumstances Sir Thomas Dunhill has found it advantageous to perform temporary gastrostomy This has the further advantage that it anchors the stomach to the parietes for a sufficient time to counteract the tendency for it to be drawn up into its old position in the chest

In hiatal hernia there is usually not much difficulty in reducing the stomach which is the invariable content. The hiatus may be sufficiently narrowed by drawing the anterior part of the opening together but care must be taken not to displace or unduly compress the œsophagus

There is a considerable risk of collapse of the lung after these operations and Stuart Harrington of the Mayo Clinic strongly advises that the patients should be nursed in an oxygen tent

Finally it must be realized that surgical intervention is always serious and that there are many possibilities of disaster Even in the presence of symptoms a conservative policy deserves serious consideration The milder troubles may often be relieved by the treatment of associated lesions and perhaps by the occasional passage of the stomach tube Phrenicotomy by relieving diaphragmatic spasm has given great relief and is a useful preliminary if surgical intervention is required (Grey Turner The British Encyclopædia of Medical Practice)

Mortality —The mortality of operative treatment is not less than 10 per cent The final results are reasonably satisfactory but should be judged by the relief which the patient obtains rather than by the subsequent X ray appearances.

Strangulation in diaphragmatic hernia —In addition to symptoms of intestinal obstruction there may be cyanosis rapid respiration and other evidences of thoracic distress Operation should be by high laparotomy It may be difficult to withdraw the contents into the abdomen A finger may be inserted by the side of the engaged viscus and the opening dilated so that it can be withdrawn Sometimes

the edge of the opening in the diaphragm may be sharp and rigid and may have to be incised with a hernia knife In these circumstances the area of constriction on the viscus must be carefully examined as there is very likely to be an area of pressure necrosis Even when the opening does not appear very tight reduction may be difficult because of distension of the viscus herniated into the chest It may be possible to decompress the latter by opening the viscus on the abdominal side and passing a catheter up through the lumen of the constricted area to deflate the part in the chest.* Whenever the condition of the patient will allow an attempt should be made to repair the defect in the diaphragm or this should be done as soon after recovery from the accident of strangulation as possible as there is a marked tendency to recurrence and often with fatal consequences

* Kidd, *Brit. Journ. Surg* July 1948, xxxvi, 142.

CHAPTER XXIV

OPERATIONS ON THE RECTUM AND ANAL CANAL

By C NAUNTON MORGAN and O V LLOYD-DAVIES

SURGICAL ANATOMY

For surgical purposes the rectum is regarded as that part of the large intestine which extends from the level of the lower border of the promontory of the sacrum and ends in front of and below the tip of the coccyx at the level of the apex of the prostate where the bowel passes through the pelvic aperture (pelvic diaphragm)

It is about 16 to 17 cm (6 to 7 in) in length and lies with the mesorectum on the front of the sacrum and coccyx and at its termina

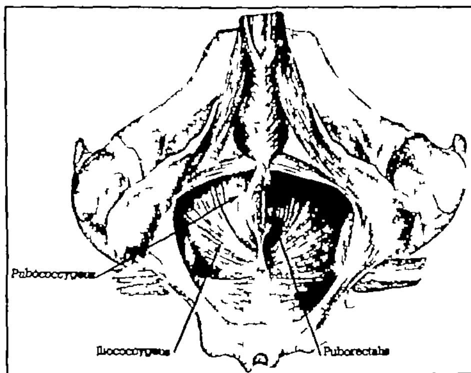


Fig 516.—Pelvic floor from below
(From Proc Roy Soc Med)

tion upon the ano-coccygeal raphe of the levator ani muscles. The pelvic diaphragm formed by the levator muscles separates the rectum from the ischio-rectal fossa on the other side

The anal canal commences at the point where the wide rectal ampulla passes through the pelvic floor at the visceral pelvic aperture and is

directed backwards forming an acute angle with the rectum The canal is an antero posterior slit 8 to 8 75 cm (1¾ to 1½ in) long and is surrounded by a strong muscular tube

The circular and longitudinal muscle coats of the rectum continue through the visceral pelvic aperture the former becoming thickened to form the internal sphincter and the latter passing through the inner portion of the subcutaneous external sphincter in a fanlike manner to gain main attachment namely to the perianal skin

The rectosigmoid has never been satisfactorily defined and we feel that in order to clarify the site of this region an arbitrary yet fixed point such as the lower border of the sacral promontory be employed

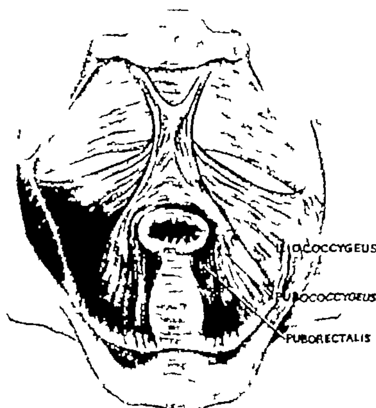


Fig 517 —The pelvic floor from above
(From Proc. Roy. Soc Med.)

It is convenient to speak of the rectosigmoid as that portion of the large intestine normally lying at the level of the sacral promontory A lesion situated below the lower border of the sacral promontory should be considered as rectal whilst those immediately above this level are of the distal sigmoid colon

In the average subject the lower half of the rectum lies entirely below the level of the peritoneum whilst the upper half is within the peritoneal cavity The infra peritoneal rectum is dilated to form the ampulla.

The pouch of Douglas or recto-vesical pouch is situated farther from the skin of the perineum in the male than in the female Its

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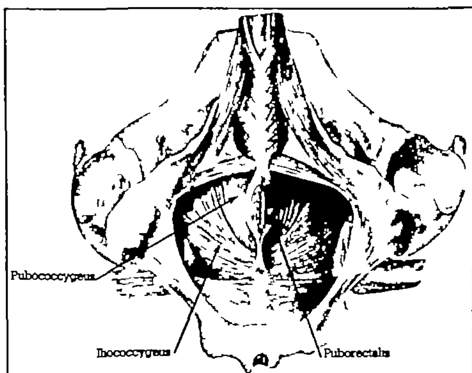


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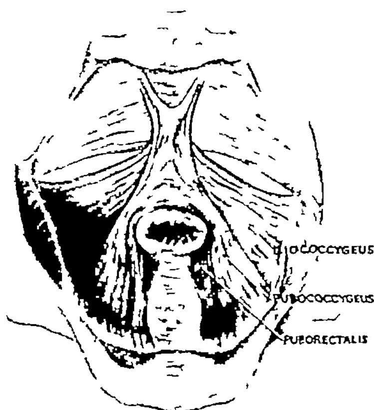


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height varies in different subjects the average being about 8 to 10 cm (3 to 4 in.) from the anal verge

The peritoneum at its lower limit is only attached loosely to the rectum and when being sought from below is easily found by cutting carefully backwards towards the anterior surface of the bowel from which it can readily be separated.

The levator ani muscle.—This muscle is composed of two main portions the Pubo-coccygeus with its sphincteric portion the Pubo-rectalis muscle placed anteriorly at the pelvic visceral aperture and the Ileo-coccygeus posteriorly The pubo-coccygeus arises from the anterior part of the white line and passes *backwards* and slightly inwards in close contact with the lateral aspect of the visceral canals. The pubo-coccygei are inserted into a raphe but their inferior borders become thickened to form the pubo-rectalis muscles whose fibres are continuous behind the rectum forming a U-shaped sling The ileo-coccygeus arises more posteriorly from the white line and runs *downwards* and inwards and is inserted into the ano-coccygeal raphe forming a diaphragm which is not in such close contact with the pelvic viscera (Figs 516 517)

Fascial planes.—The layer of parietal pelvic fascia lying on the *superior surface of the levators becomes fused with the periosteum* of the sacrum It sweeps downwards and inwards from the bony pelvic outlet and lies behind below and at the sides of the termination of the rectum forming an easily distinguishable layer often referred to as the rectal fascia of Waldeyer During perineal dissection of the rectum after removal of the coccyx and attached portions of the levator this white rather dense fascia is seen and must be incised before the mesorectum and rectum enclosed in visceral pelvic fascia can be separated readily from the front of the sacrum Attempts at separating the rectum without incising this fascia will result in hæmorrhage from sacral veins and damage to the nervi erigentes. Within the envelope of visceral pelvic fascia enclosing the rectum is situated the lymphatic space described by Miles together with the superior hæmorrhoidal vessels and accompanying lymphatic nodes and nerves The blood and lymphatic vessels lie close to the bowel wall. The pubo-coccygei as already stated are in close contact with the enveloping pelvic fascia. (Fig 518)

Above the pelvic diaphragm and fascia of Waldeyer a part of the parietal pelvic fascia becomes condensed to form stout lateral ligaments. These ligaments are in relation to the postero-lateral aspects of the rectum and hold the bowel firmly to the pelvic walls.

The inferior portions of the ligaments are the thickest and these supports become thinner superiorly fading away above as they reach the pelvic peritoneum at the sides of the rectum The lateral ligaments of the rectum contain lymphatic vessels and also the middle hæmorrhoidal vessels when present

Situated anteriorly between the front of the rectum and the posterior surface of the prostate and seminal vesicles or posterior vaginal wall is a tough fascia namely the prostato-peritoneal fascia of Denonvilliers

This fascia is the embryonic remains of the peritoneal pouch and is firmly attached to the bottom of the pouch above and to the base of the triangular ligament in the region of the apex of the prostate below

Denonvilliers's fascia consists of two layers with a potential line of cleavage between them The anterior layer is attached firmly to the prostate or vagina whilst the thick posterior layer is loosely attached to the rectal wall The space between the layers is opened when the rectum is dissected from the anterior structures

Fig 518.—Relation of the fascia propria and levators to rectum and prostate.
(From David in Dean Lewis' Practice of Surgery W F Prior Co. Inc)

As stated the rectum joins the anal canal at almost a right angle at the level of the apex of the prostate and here the anterior rectal wall is held forwards at an angle to the base of the triangular ligament and apex of the prostate by two bundles of muscles derived from the longitudinal muscle of the rectum namely the recto-urethralis muscle of Roux and also by the strong fibres of the pubo-rectalis

It is at this point where the anterior rectal wall is held forwards that the rectum or urethra may be damaged at operation

External sphincter muscle —Below the ano-rectal junction the anal canal is encircled by the external sphincter muscle The most superficial portion the subcutaneous external sphincter lying under the skin surrounding the anal orifice is separated from the more deeply situated portion by fibres from the longitudinal muscle which extend outwards across the ischio-rectal fossa. This fossa is thus divided into two parts the subcutaneous perianal space and the ischio-rectal space.

Uppermost or cephalic fibres of the external sphincter which help to form the ano-rectal ring are inseparable from the fibres of the pubo-rectalis whilst some of the more caudally placed fibres decussate behind and in front of the anal canal and gain attachment to the coccyx and central point of the perineum respectively

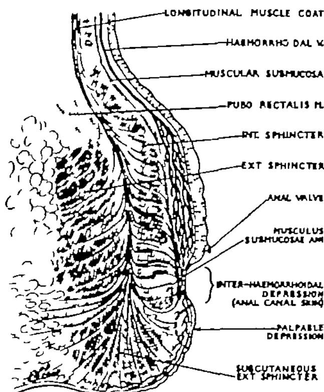


Fig 519 —Showing the attachments of the longitudinal muscle, etc., and the relation of the palpable anal intermuscular depression to the interhæmorrhoidal depression.

The subcutaneous external sphincter alone surrounds the anal orifice but when it is relaxed it is held outwards at quite a distance from the anal verge The lower border of the internal sphincter may then be placed at the anal orifice in the same transverse plane as the subcutaneous external sphincter or even below it

Longitudinal muscle —As the longitudinal muscle of the rectum passes through the pelvic aperture it fuses with the fibres of the pubo-rectalis portion of the levator to form the conjoined longitudinal

muscle of the anal canal which lies between the internal and external sphincters. This is a fibro-muscular structure which continues downwards to gain its main attachment to the skin overlying the inner portion of the subcutaneous external sphincter having passed through the fibres of this muscle. A few of its fibres pass inwards and downwards through the internal sphincter and appear to split this muscle into several segments giving it an imbricated appearance. These fibres blend with the fibres of the muscularis submucosæ which is most prominent in the region of the lower third of the internal sphincter muscle. Some strands of the longitudinal muscle pass around the lower border of the internal sphincter and also fuse with muscularis submucosæ. As already mentioned an outward extension of the

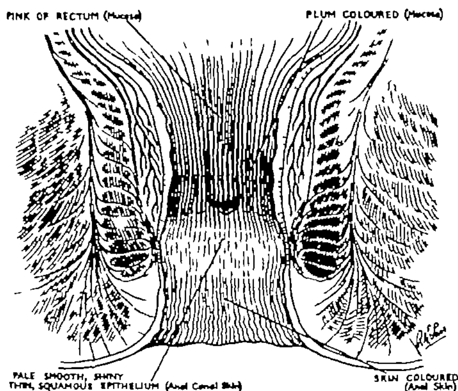


Fig. 520.—Semi-diagrammatic representation of linings of anal canal showing their relations to other structures. Note attachment of anal canal skin to deeper structures.

(Shown also in Fig. 519.)

main longitudinal muscle passes outwards above the subcutaneous external sphincter as the perianal fascia separating the perianal from the ischio-rectal space. (Fig. 521.)

Lining of the rectum and anal canal.—The rectum is lined by columnar mucous membrane which is loosely attached to the underlying muscle especially in the ampulla. This mucous membrane is pink in colour and extends downwards into the anal canal a little below the ano-rectal junction. In the anal canal the mucosa gradually becomes cuboidal and is thinner and plum coloured. Here lie the columns of Morgagni. The anal canal mucosa ends at the level of the

valves of Morgagni where the lining changes abruptly into modified squamous epithelium (anal canal skin) which continues as far as the anal verge. The longitudinal muscle is attached through the muscularis mucosæ to this modified skin just below the anal valves and thus the interhæmorrhoidal sulcus is formed between the internal and external hæmorrhoidal plexuses This sulcus varies in depth dependent upon the size of the hæmorrhoidal plexuses At the anal verge the lining becomes continuous with the true skin containing hair follicles sweat glands etc. The columnar and cuboidal zones are relatively insensitive but at and below the valves of Morgagni the lining is very sensitive (Fig 520)

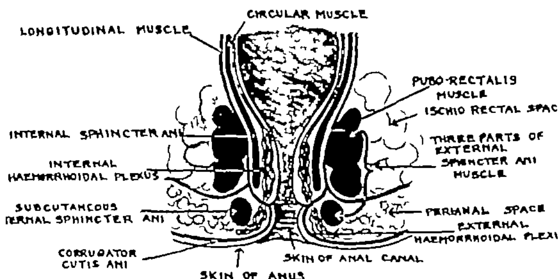


Fig 521 —Diagrammatic coronal section of anal canal to show relations of perianal space Reference to Fig 519 shows that the lower end of the internal sphincter also lies in the perianal space.

(*From Milligan, Proc. Roy. Soc. Med*)

Spaces. A. Submucous space —This space is continuous with the submucous space of the large bowel It passes downwards into the anal canal and ends at the interhæmorrhoidal depression where the fibres of the longitudinal muscle attached to the anal canal skin separate it from the perianal space (Fig 519)

B *Perianal space —The perianal fascia from the longitudinal* muscle divides the ischio-rectal fossa into two spaces the subcutaneous perianal space and the ischio-rectal space above The perianal space contains granular vascular fat the external hæmorrhoidal plexus the subcutaneous external sphincter and the lower end of the internal sphincter Infection in this space rarely spreads through the perianal fascia to involve the ischio-rectal space. The lymphatics from this area drain into the superficial inguinal lymph nodes

C. Ischio rectal spaces —These are situated on either side of the rectum below the pelvic diaphragm They lie antero-posteriorly and contain large lobules of relatively avascular fat and are traversed by the inferior hæmorrhoidal vessels and nerves The apex or anterior extension of the fossa extends deeply above the triangular ligament whilst its base lies posteriorly and is almost subcutaneous in the region of the coccyx These two ischio-rectal spaces communicate with one another behind the ano-rectal junction Infection in this space finally penetrates the perianal fascia and involves the perianal space (Fig 521)

Anatomical landmarks. **Ano rectal ring** —The dilated rectum ends abruptly where its lumen passes into the narrow anal canal closed by its surrounding muscles At this level a muscular shelf

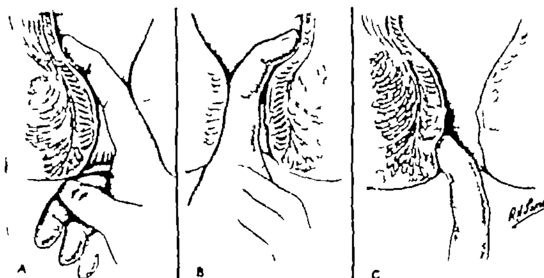


Fig. 522 —A, Palpation of ano-rectal ring, posteriorly B, Palpation of ano-rectal ring anteriorly C, The anal intermuscular depression.
(*From Postgraduate Medicine*)

can be felt with the finger and may be seen on withdrawal of a proctoscope This shelf is most marked posteriorly and laterally and is formed by the U shaped pubo-rectalis muscle sling Anteriorly the deep part of the external sphincter completes a muscle ring The pubo-rectalis muscles and anterior part of the deep external sphincter muscle together with the embraced portions of the internal sphincter and longitudinal muscle form the ano-rectal ring—an important landmark which can be felt and seen on proctoscopy In the past this ring has been mistaken for the internal sphincter Complete division of the ano-rectal ring by whatever means will lead to permanent incontinence whilst preservation of a small portion will allow control of normal fæces

Anal intermuscular depression.—This is the second palpable landmark and lies between the lower border of the internal sphincter and

the inner aspect of the external sphincter and is placed just within the anal verge When this depression is palpated with a finger the pulp of the finger will lie against the subcutaneous external sphincter whilst its tip impinges against the lower edge of the internal sphincter The visible interhæmorrhoidal sulcus bears no constant relation to the palpable intermuscular depression (Fig 522)

Subcutaneous external sphincter —In the contracted state this muscle can be seen under the skin of the anal verge in most subjects and somewhat resembles an umbrella ring Under complete surgical anæsthesia this muscle relaxes whilst the internal sphincter remains prominent Under these circumstances the internal sphincter may lie at the anal verge or by traction on the anal canal lining be readily drawn downwards (*See* Fig 526)

Blood vessels.—The blood supply is derived from the superior hæmorrhoidal artery which is a continuation of the inferior mesenteric artery the middle hæmorrhoidal vessels from the internal iliac arteries lying in the lateral ligaments and the inferior hæmorrhoidal vessels which cross the ischio-rectal spaces from the internal pubic arteries.

The superior hæmorrhoidal artery provides the main blood supply The middle hæmorrhoidal arteries may be absent and vary in size whilst the branches of the inferior hæmorrhoidal arteries lie mainly in the submucosa.

The rectum is also supplied by numerous small unnamed arteries which arise from the sacral and internal iliac vessels.

It was considered at one time that ligature of the inferior mesenteric artery above its first sigmoid branch and/or ligature of the superior hæmorrhoidal artery would produce necrosis of the rectum It is now known that only a very limited portion of the bowel may be so devitalized provided the bowel is not completely dissected from the sacrum and the main portions of the lateral ligaments are preserved This fact enables radical intrapelvic restorative resection to be performed for lesions in the upper half of the rectum.

The veins form two plexuses The internal plexus lies in the submucosa and drains into the inferior mesenteric vein via the superior hæmorrhoidal vein The radicles of the superior hæmorrhoidal vein pierce the rectal wall and like the rest of the portal system are devoid of valves

The external hæmorrhoidal plexus is situated under the skin of the perianal space amongst the fibres of insertion of the longitudinal muscle and though it drains outwards into the inferior hæmorrhoidal veins it is probable that the main drainage is upwards into the internal plexus

Nerve supply —The sympathetic nerve supply passes from the inferior mesenteric plexus and runs with the superior hæmorrhoidal vessels *though some fibres reach the rectum via the presacral nerve* It is inhibitory to the rectal wall and is excitor to the internal sphincter

The parasympathetic supply is derived from the second third and fourth sacral nerves and is spread out widely on the lateral walls of the pelvis It is antagonistic to the sympathetic.

Lymphatics.—*The lymphatics commence in plexuses in the* submucous and muscular layers of the bowel The lymphatics having pierced the rectal wall accompany the superior hæmorrhoidal vessels and run upwards along the inferior mesenteric vessels to the aortic glands. The major part of the lymphatic drainage is along this route.

Other lymphatics accompany the middle hæmorrhoidal vessels and extend to lymph nodes lying along the branches of the internal iliac vessels on the lateral walls of the pelvis. Lymphatics from the anal canal below the level of the valves of Morgagni drain into the superficial inguinal nodes

PRE OPERATIVE TREATMENT FOR HÆMORRHOIDS, ANAL FISSURE AND FISTULA CASES

The patient is given a mild aperient two nights before operation and on the evening before operation the perineum is shaved and the bowel emptied by means of an enema A tap water rectal washout is given at low pressure (two feet) not later than three hours before operation and continued until the return is clear Finally a rectal tube is passed to siphon off completely any retained fluid. In painful ano-rectal conditions such as a fissure this treatment is best omitted and an irrigation of the rectum carried out after the patient is anæsthetized.

Anæsthesia —A good general anæsthetic is satisfactory for most cases Spinal anæsthesia eliminates post-operative straining and vomiting but there is an increased incidence of post-operative urinary retention Local anæsthetics may be used for hæmorrhoidectomy un complicated by any infected lesion e g fissure or fistula

For complicated or especially high level fistulæ spinal anæsthesia or muscular relaxants must be avoided since complete muscle relaxa tion will prevent accurate palpation of the ano-rectal musculature

Operation.—Position of the patient The lithotomy position with the buttocks well over the edge of the table is generally used the inner aspect of the legs and the outer aspects of the thighs being well padded.

To operate the surgeon sits with a low instrument table in front of him

The anal canal lower rectum and perineum are cleansed with a bland antiseptic

Occasionally the rectum may be loaded with fæcal matter and it is then necessary to irrigate the rectum through a proctoscope using warm tap water or saline before proceeding to the final toilet

HÆMORRHOIDS

Indications and contra indications for operation.—Operation is indicated for third degree internal hæmorrhoids for second degree piles associated with large and permanent external skin tags and for fibrous polypi following thrombosis and infection of internal hæmorrhoids

Acute thrombosis infection and ulceration of an internal hæmorrhoid or hæmorrhoids associated with an abscess are definite contra indications to operation during this phase owing to the risk of blood borne infection

In addition hæmorrhoids resulting from visceral engorgement such as pregnancy cirrhosis of the liver or cardiac failure are obviously unsuitable for operative treatment

Hæmorrhoidectomy—The three primary internal hæmorrhoids are found in the classical positions—left lateral right posterior and right anterior (8 7 and 11 o clock) As a rule there is an associated

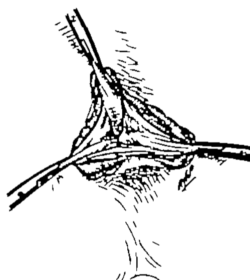


Fig 523.—Showing the triangle of exposure.

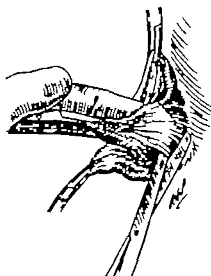


Fig 524.—Hæmorrhoidectomy Commencement of the dissection.

enlargement of the external plexus or a definite skin tag in the same positions

Complete exposure of the primary internal hæmorrhoid is obtained in the following manner without dilating the anal canal. The skin tag or skin over the enlarged portion of the external plexus is drawn outwards with a pair of plain dissecting forceps until the plum coloured anal mucosa covering the pile mass is seen. This is grasped with another pair of dissecting forceps and drawn further down until the pink rectal mucosa which covers the pile pedicle is brought into view The pedicle is then held with a pair of artery forceps—the pedicle forceps

Each pile is dealt with in a similar manner so that the anal canal lining is completely everted It is quite unnecessary to stretch the

anal canal Overstretching may produce a patulous anus whilst moderate dilatation gives rise to intra sphincteric hæmorrhages followed by pain and fibrosis

It will now be seen that each pile is composed of three parts the skin covered external portion the pile mass covered with plum-coloured anal mucosa and the pedicle covered with pink rectal mucosa.

In order to be sure that the internal hæmorrhoids are fully delivered the pink rectal mucosa must be seen producing a ridge between each of the three primary hæmorrhoids to form a triangle—the triangle of exposure (Milligan) (Fig 523)

Secondary hæmorrhoids if present will be found lying in front or behind the left lateral hæmorrhoid—these hæmorrhoids have no pedicles their bases being continuous with the mucosal ridges of the triangle of exposure.

When the internal hæmorrhoids have been fully delivered, the external plexus will be seen to have become engorged as the result of obstruction to venous return and the interhæmorrhoidal depression is more marked (See Fig 519)

The skin over the external plexus in relation to each pile is now grasped with a pair of artery forceps—the skin forceps The left lateral hæmorrhoid is dealt with first The skin forceps together with the pile pedicle forceps are held in the palm of the left hand whilst the left index finger is placed against the inner aspect of the internal sphincter All dissection is carried out with a pair of blunt nosed scissors



Fig 525—Dissection completed. Lower end of internal sphincter and the longitudinally placed fibres passing to the dissected hæmorrhoids are exposed.

A V shaped incision the apex of which is at the outer border of the external plexus is made on either side of the skin holding forceps The medial blade of the scissors is placed at the mucocutaneous junction and the lateral blade at the outer border of the external plexus and a cut made between these points. The incision passes through skin corrugator cutis ani muscle and external plexus A similar cut is made to complete the V (Fig 524)

The delineated area of skin together with the external plexus is dissected inwards as a triangular flap laying bare the underlying portion of the internal sphincter as far as its medial border which should be clearly defined Here fine longitudinal fibres situated on the inner aspect of the lower edge of the internal sphincter will be seen These fibres must *not* be divided This is a very important detail of the

operation because these fibres will be included in the ligature thus preventing upward retraction of the pile pedicle and so avoiding a large raw area in the anal canal The dissection is now complete (Fig 525) Bleeding from external vessels is controlled by temporary forceps pressure (Fig 526)

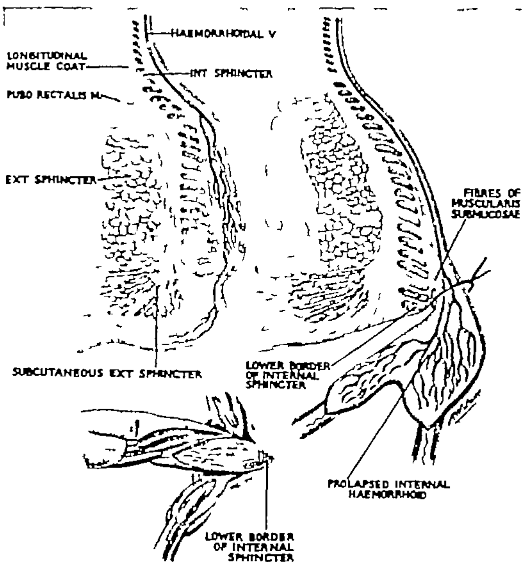


Fig 526 —Normal resting condition of anal musculature (left) and (right) muscular displacement under anæsthesia and by traction during hæmorrhoidectomy The subcutaneous external sphincter has relaxed outwards and the still tonic internal sphincter remains in situ and has been pulled downwards with the hæmorrhoid.

In order to remove the whole pile the assistant exercises firm traction on the pile pedicle forceps whilst a ligature of No 16 hollow woven silk or strong chromic catgut with or without transfixion is placed in position at the level of the inner border of the exposed internal

sphincter This traction is released before the first knot is finally tightened (Fig 527) The pile pedicle forceps is now removed and applied to the ends of the ligature This forceps and the skin forceps are gently held aside by an assistant

Dissection and ligation of the two remaining primary hæmorrhoids is now carried out the right anterior hæmorrhoid being dealt with last in order to avoid the field being obscured by external plexus bleeding Care must be taken when making the V-shaped cuts to ensure that an adequate and complete bridge of skin and anal canal lining is left between the ligatured piles

Secondary hæmorrhoids when they occur can usually be incorporated in the ligature of the left lateral or right posterior hæmorrhoid

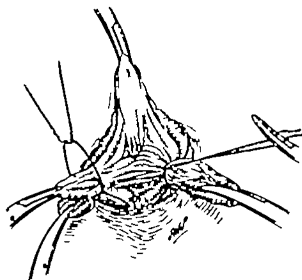


Fig 527 —The left lateral hæmorrhoid has been ligated. The right posterior hæmorrhoid in process of being ligatured.

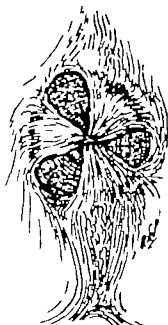


Fig 528 —Showing the three flat perianal wounds with complete skin bridges in between.

but when such a pile appears to be isolated it may be dealt with by separate ligation at level of the ridge of the triangle of exposure.

The greater part of ligated pile masses is now excised leaving sufficient tissue to prevent slipping of the ligatures The long ends of the ligatures are cut short and the everted anal canal readily inverts. It will be found that the ligatured pedicles remain in the anal canal and do not retract upwards.

The final stage of the operation is concerned with the adequate removal of perianal skin in order to prevent the formation of troublesome skin tags.

A strip of moist gauze is inserted into the anal canal to complete the inversion of the anal margin

The three perianal skin wounds will now be seen and between them three complete bridges of skin and anal canal lining

On gently withdrawing the gauze strip overhanging redundant skin at the edges of the perianal wounds will be revealed and should be excised in order to leave flat wounds rather like a three-leafed clover (*See* Fig 528) Enlarged veins of the external plexus under the cutaneous portions of the bridges should be dissected out but great care should be taken to retain complete epithelial interhæmorrhoidal bridges.

Bleeding from the external plexus can usually be controlled by forceps pressure and whenever possible it is best to avoid ligatures. If ligatures have to be used the ends should be left long for removal at the time of the first dressing Slight pressure with gauze soaked in 1 to 1 000 adrenaline will often be found useful

A small rubber tube (½ in bore and 2½ in long) may now be inserted into the anal canal. Small flat triangular gauze dressings 1½ in long moistened with a weak antiseptic solution and the apex lubricated with petroleum jelly are now inserted into the anal canal alongside the tube. The dressings are placed on the inter hæmorrhoidal skin bridges in order to support them and so prevent œdema. Instead of the tube a piece of soft Paul s tubing may be used and no dressings inserted into the anal canal.

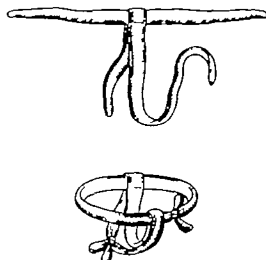


Fig 529 —Miles bandage. One square yard of muslin is folded to form a triangle. This is then lightly rolled around a small quantity of cotton wool to make a waist band. To the centre of this band is stitched a double layer of 4 inch gauze to form two tails, one 2 feet long and the other 4 feet in length. These tails are tied as in the illustration with the knot over the position of the anus.

A moist gauze pad is applied and finally a large cotton wool pad firmly held in place with a Miles or T bandage (Fig 529)

Complications. 1 Reactionary hæmorrhage.—Bleeding occurring soon after the operation usually comes from external plexus vessels in the perianal wounds. The vessel must be located and ligated

When a pedicle ligature slips hæmorrhage can be very severe and there may be general signs of blood loss It is fortunately very rare Blood may be seen coming down the inserted tube or alternatively the bowel may contract and evacuate a large quantity of blood together with the tube and dressings

It is necessary to return the patient to the operating theatre and under anæsthesia the pedicle must be religatured. Occasionally it is necessary to underrun the pedicle at a higher level when the vessels have retracted A blood transfusion may be necessary

2 Secondary hæmorrhage —This is rare and occurs between the fifth and twelfth post-operative days. The patient usually has an

urgent desire to evacuate the bowel and passes a large quantity of fresh and semi altered blood—general signs of blood loss may be present

The patient is given morphia or omnopon and a tubular proctoscope passed into the rectum which is then irrigated with warm tap water to remove any retained blood A rubber tube 10 cm (4 in) long and 1 to 1 5 cm (½ in) diameter with a petroleum jelly gauze roll wound firmly around about half its length is now inserted through the proctoscope into the rectum The speculum is slowly withdrawn over the uncovered portion of the tube which projects outside the anal canal A large safety pin is now passed through the tube and a roll of gauze wound around the projecting portion of the tube between the pin and the anus whilst steady downward traction is exerted

This maintains pressure upon the ano-rectal ring from above and controls the bleeding

The foot of the bed is raised on blocks and a half hourly pulse chart is kept A blood transfusion may be necessary

The tube is removed 48 hours later following the injection of morphia and the bowels are confined for a further day The gentle instillation of olive oil into the rectum and suitable laxatives will enable the bowels to be opened smoothly and a commode or bedpan should be used for a further three or four days the patient should be kept in bed and not allowed up until the blood count has reached a reasonable level.

3 Stricture —This may occur at two levels First at the ano-rectal ring and is due either to sepsis or too high a ligation of the rectal mucous membrane. Correct delivery of the hæmorrhoids to produce the triangle of exposure will obviate this latter cause

Secondly at the anal verge constriction at this level is avoided if adequate interhæmorrhoidal bridges of skin and anal lining are retained.

Both forms can usually be corrected by passing a suitable dilator e.g St. Mark s Hospital pattern daily for several weeks Occasional stenosis at the anus requires further operative treatment in which event the condition is treated by a formal fissure operation

Very rarely submucous or subcutaneous abscesses or fistulæ may develop due to infection and faulty healing and surgical intervention will be necessary

The inserted post-operative dressings are intended to keep the wounds flat and enable second intention healing to occur though as stated these may well be excluded.

FISSURE IN ANO

An anal fissure is situated in the midline more commonly posteriorly than anteriorly There are two main types

1 The acute superficial type recognized by radially placed longitudinal fibres lying in its base

2 The chronic type which is indurated and in the base of which the white circular fibres of the internal sphincter will be seen

Superficial fissures usually yield to non-operative management but chronic fissures nearly always require operation especially when complicated by

1 Abscess and fistula formation
2. Enlarged anal papillæ or fibrous polyps.
3 Fibrous anal stenosis
4 Hæmorrhoids.

A fissure should usually be excised and further in order to widen the anal orifice the prominent lower portion of the internal sphincter should be divided or a portion excised.

In addition it is necessary to remove a sufficient area of perianal skin and divide the subcutaneous external sphincter to promote external drainage and to ensure that the flat wound produced heals by second intention Primary suture plays no part in the treatment of anal wounds.

Operations for fissure in ano —With the patient under general anæsthesia the fissure is exposed and completely excised together with a triangular area of perianal skin approximately 1¼ in. in length the fissure occupying the apex of the triangle. Any associated polyp sentinel tag or fistulous track must also be excised and an upward submucous extension if present dealt with by means of a strangulating ligature.

The tight somewhat fibrous muscle band formed mainly by the internal sphincter and sometimes partly by the subcutaneous external sphincter will be seen forming a ridge at the level of the anal verge. A portion of this band of muscle is deliberately excised. When this has been done a finger is passed along the surface of the wound into the anal canal and may encounter a further obstructing ridge formed by individual fibres of the internal sphincter This ridge must be divided in order to procure a completely smooth flat wound. Over hanging skin at the anal verge where the wound runs into the anal canal is now removed to prevent œdema and bridging of epithelium

A small rubber tube is introduced and flat dressings of four or six layers of moistened gauze are now inserted into the anal canal and placed firmly on the floor of the wound The object of this dressing is to keep the wound flat to prevent bridging of granulation tissue and swelling of the external hæmorrhoidal plexus

An alternative method of operative treatment is division of the internal sphincter fibres from within the anal canal. A small bivalve speculum is introduced into the anal canal and a pledget of gauze soaked in adrenaline (1 in 1 000) applied to the anal canal lining in the midline posteriorly A vertical incision about half to three-quarters of an inch in length is made through the fissure and the circular white fibres of the internal sphincter muscle which are put on the stretch by the inserted speculum will be seen and the lower edge of the

muscle demonstrated These white circular muscle fibres are divided until the smooth surface of the longitudinal muscle of the anal canal is encountered The division of the circular fibres is continued downwards to the anal verge and also upwards to the full length of the incision At the distal extremity of this incision some of the innermost fibres of the subcutaneous external sphincter which are pink in colour may be seen and should be divided (Fig 530) Only a

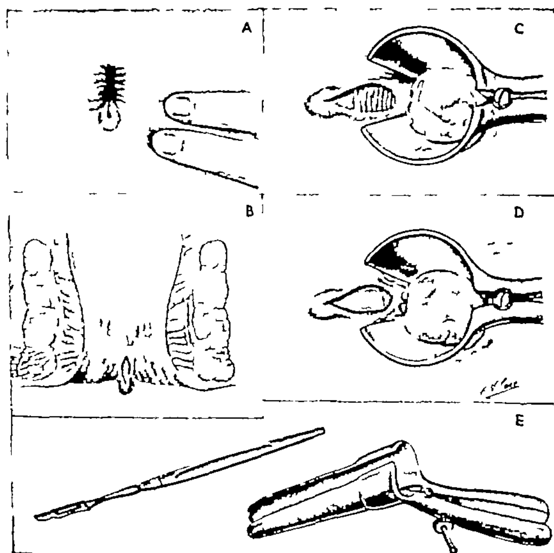


Fig 530 —Fissure in ano Internal sphincterotomy

A, Dorsal fissure in ano. B, Dorsal fissure in ano (on section) C, Bivalve speculum in situ. A longitudinal incision has been made through the base of fissure exposing white transversely placed fibres of internal sphincter (In Figs. C and D the patient would be lying on his side) D The white circular fibres of the internal sphincter have been divided for about ½ in. exposing the smooth longitudinal muscle fibres. E Bivalve speculum and small knife

very small area of skin at the anal verge requires removal It is not necessary to remove any of the lining of the anal canal The wound is now lightly packed with a small piece of flat petroleum jelly gauze

As already stated a chronic anterior fissure is not so common This is also treated by division of the internal sphincter through a

laterally or even posteriorly placed incision owing to the rigidity of the perineal body. Special care must be taken during healing.

When large internal hæmorrhoids are found to be coincident with a chronic fissure requiring operation they are best dealt with at the time. The operation field should be carefully planned in order to retain if possible three complete skin and mucous membrane bridges but in most cases it will be found necessary to incorporate the external wounds of the left lateral and right posterior hæmorrhoids in the fissure wound thus leaving only two interhæmorrhoidal skin bridges.

The post-operative care of these cases is described later.

SUBMUCOUS PERIANAL AND ISCHIO-RECTAL ABSCESS

Every abscess in this region should be treated as an emergency and efficient drainage established as soon as possible. This will limit the extension of infection into the various spaces already mentioned.

An abscess in the submucous space is felt in the anal canal as an extremely tender bulge which extends upwards for a variable distance into the rectum. Occasionally the perianal space is also involved. It is opened by inserting a pair of sinus forceps through its lower bulging end, the opening then being gently stretched as the forceps are withdrawn (Hilton's method).

When the acute phase has subsided a fistula may remain and require further treatment (*vide infra*). The fistula is detected by the presence of submucous induration and by the passage of a probe.

A perianal abscess can be distinguished from an ischio-rectal abscess by the absence of induration in the ischio-rectal space when the latter is palpated through the rectal wall above the ano-rectal ring.

When its full extent has been determined by palpation the abscess is incised and all the overlying skin is excised. Care should be taken not to incise the perianal fascia by cutting too deeply in order to avoid infection of the ischio-rectal space.

Healing occurs by the epithelialization of granulation tissue (second intention) and during this process the wound should be periodically examined with a probe to exclude the presence of a low anal fistula.

Infection of the ischio-rectal space as a rule rapidly spreads throughout the greater part of the space but physical signs in the perineum may occur late owing to the barrier of the perianal fascia and the toughness of the overlying skin. Early diagnosis is made by palpation through the rectal wall above the ano-rectal ring. Both sides should be palpated for comparison.

This abscess is incised in a cruciate manner and then cautiously explored with a finger. A sharp foreign body may very occasionally be found. Fibrous septa are then broken down and any anterior extension or extension of the opposite side drained. All the skin overlying the abscess cavity is removed, care being taken to avoid removal of skin overlying the ischial tuberosity. A V shaped excision of skin at the anal verge in continuity with the main wound will prevent œdema of the anal margin.

Flat gauze dressings damped in a weak antiseptic solution are placed in the cavity and a large pad and a T bandage applied

Should a brisk hæmorrhage be encountered this is dealt with by firmly packing the wound since the tissues are usually too necrotic to hold a ligature The after-care is the same as that for ano-rectal fistula (*vide infra*) Periodic examination during the healing process will be necessary to exclude the presence of an internal opening into the bowel

FISTULA IN ANO

Radical surgery offers the only cure for a fistula in ano of pyogenic origin.

The importance of the ano-rectal musculature for the maintenance of continence has already been emphasized

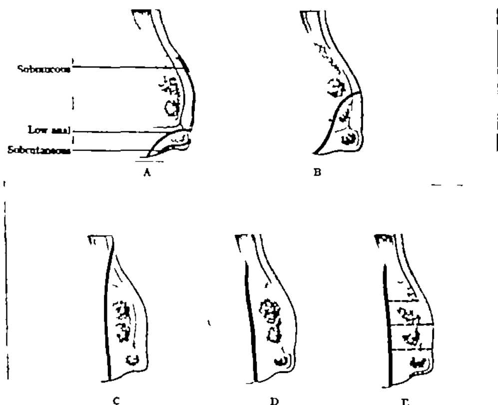


Fig 531 —Classification of fistula in ano Ano-rectal fistulæ A, Submucous, low anal and subcutaneous fistulæ B High anal fistula C, Ano-rectal fistula of very rare type D Ano-rectal fistula E, Ano-rectal fistula with possible extension into bowel.

The principle of the treatment of an anal fistula by laying open of the main track and all its extensions and the fashioning of a flat wound by adequate removal of skin and subcutaneous fat to allow healing by the epithelialization of granulation tissue (second intention) will usually require division of a portion of the ano-rectal musculature

For this reason a classification of fistulæ based on the relation of the main track of the fistula to the ano-rectal musculature has been adopted at St Mark s Hospital

Classification. (Fig 531 *)

A { (1) *Subcutaneous*
(2) *Submucous* —Main track lying under skin or mucosa. (No muscle requires division for the cure of this type.) (5 per cent.)

B *Anal*
(1) *Low* main track lies at anal intermuscular depression (75 per cent)
(2) *High* main track lies above anal intermuscular depression but below ano-rectal ring (15 per cent.)

C. *Ano-rectal* —Main track extends above level of ano-rectal ring (5 per cent.)

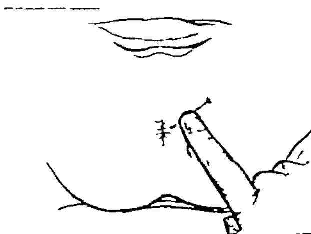


Fig 532.—Anal fistula finger is shown palpating subcutaneous induration.

The tracks of the large majority of fistulæ the low anal and subcutaneous types can be felt as indurated cords running radially under the skin towards the anal canal A probe in the main track of a low anal or a subcutaneous fistula will be found to pass *transversely* towards the anus whilst in the case of an ano-rectal fistula, it will be *parallel* to the anal canal. The main track of a high anal fistula passes *obliquely* towards the anal canal and the portion of the track may be felt by deep palpation whilst the inserted probe lies obliquely

Operation.—At operation the ramifications of a fistula are found by palpation with the index finger or between the finger and thumb by searching with a probe and by the discovery of granulation tissue. After curetting the granulation tissue from the fibrous wall of the main track extensions from it are sought where slight depressions containing adherent granulations are seen.

A. (1) Subcutaneous fistula.—This simple fistula lying in the perianal space is completely excised without division of any portion

Figs. 531 [illegible] 533 534 537 538–42 and 545 are reproduced by kind permission from *British Surgical Practice* Butterworth. Figs. 543–47 are also reproduced by kind permission of H R. Thomson

of the anal musculature The skin edges are excised to produce a flat wound.

(2) **Submucous fistula.**—This may exist alone or complicate the other types Owing to the difficulty of control of hæmorrhage from the submucous vessels lying in the roof of the fistula division of the roof of the track by incision is inadvisable A grooved malleable probe director is passed upwards along the track to its full length and then pushed through the mucosa into the lumen of the rectum The tip of the probe is now gently delivered through the anus and a piece of strong silk threaded on a bodkin probe is passed along the director which is then withdrawn The bodkin is now removed and the silk is tied as a strangulating ligature in order to destroy the roof of the fistula The ligature cuts out in from 5 to 10 days Several such ligatures may be necessary to destroy the mucosal roof

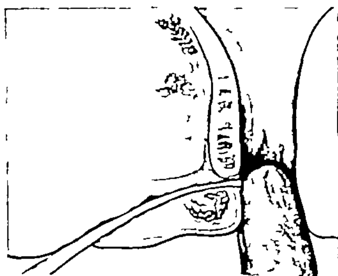


Fig 533 —Anal fistula (low) Finger palpating end of probe at anal intermuscular depression.

completely In such cases all the ligature material should be placed in position before any one of them is tied since a tightened ligature will distort the track.

B **Anal fistula.** (1) *Low anal* —The internal opening of the main track lies at the anal intermuscular depression just above the subcutaneous external sphincter it may be a distinct opening or more commonly a tiny indurated depression or elevation (*See* Fig 533)

A probe pointed director is passed through an external opening along the palpated track towards the finger lying at the internal opening *it will be noted that the probe lies transversely to the direction of the anal canal* Sometimes difficulty may be experienced in passing the end of the probe through the minute internal opening in which event when the probe is distinctly felt just under the lining of the anal canal it may be pushed through on to the finger

This main track is completely laid open by cutting through the subcutaneous sphincter on to the probe Any subcutaneous tracks lying in the perianal space are similarly treated. Multiple external openings into the perianal space may be present the fibrous walls of the tracks are completely removed and sufficient overlying skin excised in order to fashion a flat wound.

(2) *High anal*—The internal opening will be found to lie above the anal intermuscular depression but below the ano-rectal ring This fistula is laid open to the surface in a similar manner to the low anal variety although most of the external sphincter muscular ring and a portion of the internal sphincter may require division Fistulæ of this type are intramuscular and subsidiary tracks running amongst the muscle fibres of the external sphincter may be found.

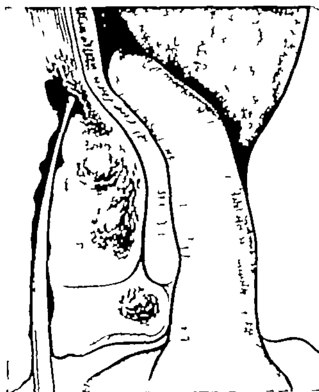


Fig 534.—Ano-rectal fistula involving ischio-rectal and perianal spaces. Finger palpating induration and point of probe above the ano-rectal ring

Although these tracks extend above the level of the perianal space they do not enter the ischio-rectal space but are apparently confined by the sheaths of the external sphincter muscles. It is likely that these fistulæ arise from infection in vestigial intramuscular glands

Owing to the proximity of the ano-rectal ring frequent palpation to localize this important structure will be necessary before finally laying open the main track into the anal canal Associated subcutaneous tracks lying in the perianal space may also be present

C. Ano-rectal fistula.—This fistula is called ano-rectal because its

main track extends above the ano-rectal ring and lies *parallel* to both the anal canal and termination of the rectum Its deep extensions lie in close apposition to the rectal wall being only separated from it by the pubo-coccygeus and pubo-rectalis muscle fibres and the tough visceral pelvic fascia of Waldeyer

The external opening of the main track is usually single and lies within an inch of the anal verge When a probe is passed along this track it will be found to pass directly upwards parallel to the anal canal in contrast to the transverse position of the probe in the main track of low anal fistula.

The ano-rectal fistulous track is not palpable under the perianal skin nor through the anal canal but extra rectal induration will be felt through the rectal wall above the level of the ano-rectal ring (*See* Fig 584)

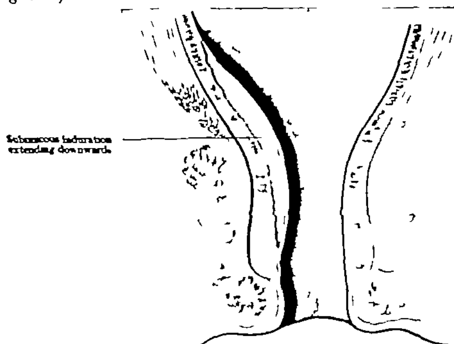


Fig 535—Demonstrating that infection in the submucous space will extend below the level of the ano-rectal ring into the anal canal.

The fact that this extra rectal induration is only palpable *above* the ano-rectal ring will help to distinguish it from induration resulting from submucous space infection since induration in this space will extend downwards into the anal canal (Fig 585)

The induration felt in an ano-rectal fistula is produced by the walls of its main abscess cavity situated deeply in the ischio-rectal space and lying upon the pubo-coccygeus muscle which forms the inner wall of this space Careful palpation may reveal induration extending *forwards* to the apex of the ischio-rectal space along the fibres of the muscle This is the *anterior extension* Should infection extend to the opposite ischio-rectal space an indurated cord will be palpable passing along the sling fibres of the pubo-rectalis behind the ano-rectal junction to the opposite side—*extension to opposite side*

When this has occurred an anterior extension in the opposite space may also be present.

In the majority of instances a track into the bowel is present but fortunately lies at any level below the ano-rectal ring

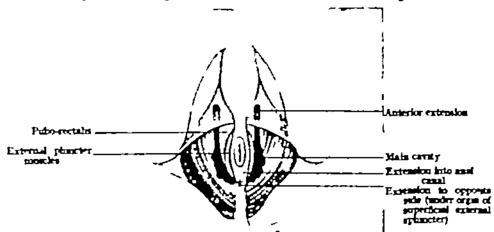


Fig 536.—The pattern of an ano-rectal fistula showing relation of extensions to the muscles.



Fig 537 —Ano-rectal fistula. Finger palpating extension to opposite ischio-rectal space above ano-rectal ring

The pattern of these fistulæ is constant and the anterior extension the extension to the opposite side and the extension into the bowel must be sought (Figs 536 537)

Operation.—The ischio-rectal space becomes quite superficial posteriorly at the side of the coccyx and for this reason the depths of the space are first exposed by a backward cut All incisions must be made with a finger in the rectum in order to avoid damage to the bowel and sphincter muscles.

A grooved probe director is passed along the main track and is completely freed by a deep incision made directly backwards to the side of the coccyx The main cavity can now be seen in the depths by retraction of the wound edges and granulation tissue is gently curetted from its fibrous walls The anterior extension is next looked for by probing the anterior wall of the main cavity This extension is laid open by a forward incision along the probe and the base of the triangular ligament and transverse perineal muscle frequently require division.

The extension to the opposite side is next sought by following granulation tissue by palpation and the passage of a probe Should

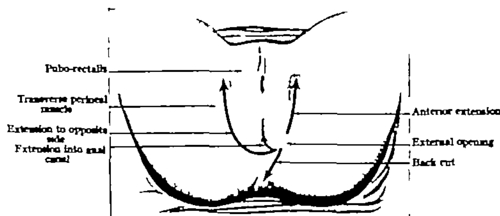


Fig 538 —Plan of operative approach to ano-rectal fistula.

the opposite space be involved the extensions here are opened to surface in a similar manner (Fig 528)

The inner wall of the main cavity and the extension in the direction of the opposite side can now be fully inspected. After curetting granulation tissue an adherent dimple of granulations will usually reveal the position of the track into the bowel the relation of this track to the ano-rectal ring is carefully assessed. Light anæsthesia at this stage is essential Provided the track lies below even a small portion of the ano-rectal ring it may be laid open to the surface without risk of incontinence.

In order to ensure healing by second intention of this large deep but narrow wound especially anteriorly between the descending pubic rami wide removal of skin and overhanging fat of the ischio-rectal space is necessary

Care should be taken to remove sufficient skin at the anal verge on the inner side of the cavity where the track into the anal canal has been laid open Even in cases with no track into the anal canal

skin at the anal verge must be removed to prevent œdema and to flatten this aspect of the wound. Division of the subcutaneous external sphincter together with the lower portion of the internal sphincter will further help to reduce the depth of the inner wall of the cavity

The fibrous walls of the fistula are now excised as far as is possible, remembering the close relationship to the rectal wall. As few vessels as possible are ligatured and in order to avoid buried suture material, all ligatures are left with long ends and removed at the first dressing (Fig 539)



Fig 539 —Showing general approach to ano-rectal fistula.

Fistulæ extending above the visceral pelvic fascia of Waldeyer are supralevator (pelvi rectal) and in our experience are very rare

Supralevator (pelvi rectal) fistulæ are usually secondary to inflammation extending downwards from within the pelvis. The primary disease may be salpingitis an infected dermoid a rectal growth or granuloma especially tuberculosis or actinomycosis etc. It is disastrous but yet easy to convert an ano-rectal into a pelvi rectal fistula by incision of the induration palpable above the ano-rectal ring in the former condition. The treatment of pelvi rectal fistula is the treatment of the primary condition

Dressings.—Flat moist gauze dressings are laid on the wound from its depths to the skin surface The large cavity left after operation upon an ano-rectal fistula will require especially careful dressing in order to keep the surfaces of the wound apart. (After-care *vide infra*)

Tuberculous fistula.—About 12 per cent of fistulæ in ano are of tuberculous origin. The majority of these cases have evidence of past or present pulmonary tuberculosis but on the other hand the incidence of tuberculous fistulæ in patients suffering from active pulmonary tuberculosis is only 4 per cent. (Brompton Hospital)

Tuberculous fistulæ are also found in association with tuberculous ulceration of the rectum colon and genito-urinary tract

In general a tuberculous fistula may be distinguished clinically by the typical granulation tissue the thin discharge and the absence of induration

These fistulæ are often accompanied by extensive tracking and

erosion of the sphincter muscles Occasionally a tuberculous fistula can only be distinguished from a pyogenic fistula by the histology and it is wise to have all fistulous tracks examined histologically

The prognosis in these cases depends mainly upon the presence of tuberculosis elsewhere Even in the absence of proven pulmonary or intestinal tubercle a guarded prognosis should be given if the patient s general condition is not good

Treatment.—When there is active tubercle elsewhere or the patient s condition is poor surgical treatment should be limited to the removal of a small area of skin to provide drainage. The general and specific treatment for tuberculosis should be instituted.

In otherwise healthy subjects these fistulæ should be treated on somewhat similar lines to those already described for pyogenic fistulæ Adequate drainage is provided by the removal of overlying skin but care must be taken not to open up uninvolved tissue. Therefore granulation tissue should not be curetted or any fibrous barrier excised. The exposed granulations should be destroyed by means of the coagulating diathermy current Streptomycin used generally and locally and isonicotinic acid hydrazide have proved useful.

POST-OPERATIVE CARE OF HÆMORRHOIDS, FISSURE AND FISTULA CASES

Control of pain.—During the first 24 hours the liberal and regular use of morphia or its derivatives is advised if the patient has any pain The bandage should be kept tight since firm pressure will diminish pain

Injections of omnopon gr ⅓ or morphia gr ⅙ to ¼ or tablets Codeine Co (gr x) should be given as necessary (up to 2 hourly) during the first 24 hours

Retention of urine.—After 12 hours the patient may be allowed to get out of bed to pass urine and if this is unsuccessful 1 c.c of Carbacol or Moryl may be given intramuscularly Rarely is it necessary to pass a catheter

First day—If a tube has been inserted into the rectum it is removed by gentle traction leaving *in situ* the gauze that has been tucked in alongside. These gauze inner dressings are damped with a weak antiseptic solution a cotton wool pad applied and held in position firmly with a T or Miles bandage. As already indicated it is not essential to insert dressings into the anal canal following hæmorrhoid ectomy Fluid diet

Second day—Damp inner dressing and apply damp outer dressing as above morning and evening Light or normal diet

Third day—First dressing under anæsthesia. Pentothal (0 5 grm) is usually adequate Patient should lie on the left side with the buttocks well over the edge of the bed Place mackintosh under the buttocks and drape into bucket -Irrigate inner dressing with

hydrogen peroxide 1–40 and remove them gently under anæsthesia. Arachis or olive oil (5 oz.) is now run into the rectum using a large glass funnel attached to a flatus tube (No 18 English) Insert a small corner of folded gauze soaked in a weak antiseptic solution the apex being lubricated with Zinc and Ol Ric ointment Apply pad and T bandage. An anæsthetic is of course unnecessary if no gauze dressings were inserted at operation.

Third night. *Aperient*—Give liquid cascara or senna extract and paraffin 1 oz.

Fourth morning—If the bowels are not opened warm magnesium hydroxide ½ to 1 oz is given. A warm bath *immediately* following a bowel action gives much relief

Fifth day—If the bowels have not yet been opened an enema saponis with olive oil is administered.

Sixth day—A finger lubricated with 2 per cent Xylocaine Gel 5 per cent. Decicaine or Cocaine ointment is passed into the anal canal in all cases of fissure. Next a St Mark s Hospital dilator *warmed* and lubricated with a surgical lubricant is gently inserted to its full length Thereafter the above treatment is carried out after the bi daily baths and before the dressings Hæmorrhoid cases usually do not require a dilator but a finger must be passed twice daily from the sixth day onwards A dilator is used if there is excessive muscle spasm

The bowel actions are regulated with diminishing doses of magnesium hydroxide cascara or senna according to individual needs care should be taken not to purge the patient and to avoid fluid stools. The addition of one of the bulk forming substances such as Normacol or Isogel 1 drachm at night will aid the re-establishment of normal bowel habit whilst the other aperients are gradually diminished. The patient should be advised to continue with the Normacol or Isogel after discharge until it is no longer necessary

Daily dressings.—The routine for dressings is as follows —

The patient is placed on the left side as described above for the first dressing

The external wounds are gently irrigated from a douche-can fitted with a yard of rubber tubing (all carefully sterilized before use) with 1 pint of a weak antiseptic solution The solution commonly used is 1–40 of 1 per cent. electrolytic sodium hyperchlorite

A corner of folded gauze is soaked in a weak antiseptic solution the apex lubricated with a surgical lubricant and carefully inserted into the anal canal with a sinus forceps the excess being placed flat on the external wounds

After a week red lotion is used for alternate dressings The patient should take a bath on the morning of the fourth day and thereafter morning and evening before the dressings and after each bowel action

The patient may be allowed to walk to the bath and to the lavatory

but apart from this should be in bed for the greater part of each day until the tenth day

If the dressings or the passage of a dilator are painful a sedative is given half to three-quarters of an hour beforehand

These dressings are continued and the patient is usually kept in hospital until epithelialization of the wounds is almost complete.

The huge and deep cavity following the radical treatment of an ano-rectal fistula requires special care as follows —

Apart from the twice daily damping of the inserted dressings the wound is left undisturbed until the fifth day

Now with the dressings still *in situ* a small soap and water enema containing olive oil is given using a small soft rubber catheter passed into the rectum to above the level of the dressings When the bowels have acted or the enema returned the first dressing is carried out under intravenous anæsthesia. This is best done in the lithotomy position in the operation theatre The dressings are removed the wound irrigated carefully inspected bridging granulations broken down and redressed as at operation

During the next week the bowels are opened on alternate days by means of aperients and enemata and the wounds redressed under anæsthesia on each occasion By this time the wound is comparatively painless and the usual routine of baths and dressings carried out

Thorough inspection of these wounds in the operating theatre is necessary at approximately fortnightly intervals in order to break down granulation tissue bridging across the cavity especially in the anterior extension of the wound to prevent too rapid surface healing and to locate any undiscovered extension.

RECTAL PROLAPSE

Mucous membrane prolapse (incomplete)—(*a*) This occurs most commonly in children If the condition persists in spite of the removal of possible causes and the correction of irregular bowel habit we have found that submucous injection of 5 per cent phenol in almond oil is very effective and no other more elaborate method is necessary

Method of injection.—With the child under a general anæsthetic and in the lithotomy position the prolapsing mucous membrane is drawn down to its fullest extent by non-traumatic tissue forceps A complete ring of submucous injections is given at apex of the prolapse using 8 to 10 c.c. of the solution The prolapse is reduced a full-sized proctoscope inserted and a further ring of submucous injections (6 to 8 c.c.) given just above the level of the ano-rectal ring

The patient is discharged from hospital five to seven days later when normal bowel habit has been restored and only very rarely is a second series of injections necessary

(*b*) In the adult mucous membrane prolapse most commonly occurs from a coalescence of third degree hæmorrhoids

Before considering any operative procedure care should be taken to exclude any cause for straining such as difficulty with micturition the presence of a pelvic tumour and the abuse of purgatives etc.

Mucosal prolapse was also sometimes seen to follow the now discarded Whitehead operation for hæmorrhoids and may occur after an extensive fistula operation

When the sphincter tone is normal treatment is by excision of the prolapsing mucosa after transfixion and ligature In cases in which the prolapse is completely circumferential, it should be divided into three portions which are separately transfixed and ligated If the tissue to be ligated is broad and bulky a Goodsall's stitch will be found useful (Fig 540)

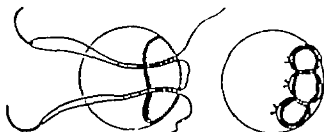


Fig 540 —Diagram illustrating Goodsall's ligature with two needles.

Elderly subjects are sometimes seen with a mucosal prolapse associated with a patulous anal canal If the condition is not controlled by submucous injections of 5 per cent phenol in oil (without anæsthesia) a Thiersch operation as described later may be necessary

Complete prolapse.—In these cases the whole rectal wall prolapses through the visceral pelvic aperture and the condition may be regarded as a sliding hernia of the pouch of Douglas or the recto-vesical pouch Rectal sensation is often impaired for no obvious reason and therefore



Fig 541 Complete rectal prolapse showing circular folds of mucosa.

it is wise to assess the sensitivity of the rectal ampulla by air distention before operation (Fig 541)

A large number of operations have been devised for the cure of this distressing and intractable condition but this surgical problem is not yet completely solved

Two approaches have been used in the operative treatment of this condition Abdominal perineal and in recent years a combined approach by both routes *

Because many of these patients are elderly an extensive procedure is hazardous and since there is no guarantee of complete success a perineal approach is wiser in the majority of cases

PERINEAL OPERATIONS

Rectosigmoidectomy —The object of the operation is to excise the prolapsing portion of the bowel and make an anastomosis

As for all operations on the large intestine the bowel is thoroughly prepared (*see* Carcinoma of the Rectum) Facilities should be available for transfusion. General anæsthesia is used and the patient is placed in the lithotomy position

The rectum is prolapsed by pulling it downwards with sponge-holding forceps and then thoroughly cleansed

A transverse semi-circular incision about 2 in in extent is made on the anterior wall of the prolapse about 1 in from the muco-cutaneous junction The incision is deepened through the whole thickness of the rectal wall until the extra peritoneal fat is revealed and then extended laterally to include half the circumference of the prolapse Numerous submucous vessels will be divided and should be immediately secured and ligatured with plain catgut (Fig 542)

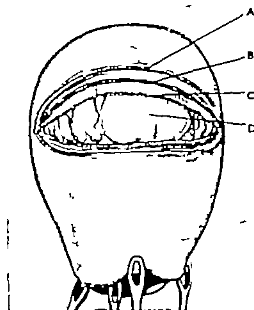


Fig 542 —Division of layers of rectal wall. The muscle layers should be divided at a lower level than the mucosa The separate layers are more easily seen in œdematous bowel. (A, cut edge of mucous membrane B cut edge of circular muscle C longitudinal muscle D extraperitoneal fat.)

The incision is deepened until the peritoneum is seen and this is then opened transversely into the sulci on either side of the colon The thin posterior wall of the vagina may bulge into the wound and unless identified may be mistaken for the peritoneal sac (Figs 543 544)

* J E Dunphy 1948, Surg Gynec Obstet 86, 434

The redundant colon is now pulled down to its full extent and the crescentic opening of the peritoneum closed as high as possible A No 0 chromic catgut atraumatic suture is used commencing at one corner of the crescent care being taken to close the deep lateral sulcus completely and to avoid penetration of the whole thickness of the bowel wall. This suture terminates in the midline and a similar suture is used for the opposite side (Fig 545)

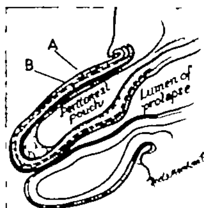


Fig 543.—Diagram showing section of muscle layer B at a lower level than section of mucosa A, to allow for retraction of longitudinal muscle.

The anterior and lateral walls of the colon are now cut across transversely at the level of the retained rectal cuff Three mattress guide sutures of No 1 chromic catgut are inserted through all layers of the rectal cuff and the full thickness of the wall of the colon. These are placed in the midline anteriorly and on either side. The ends of these ligatures are held in forceps The anterior half of the anastomosis is now completed by inserting further through and through or mattress sutures about ¼ in apart incorporating all layers. Especial care should be taken on the rectal aspect of the anastomosis where the muscle layers tend to retract. (Fig 546)

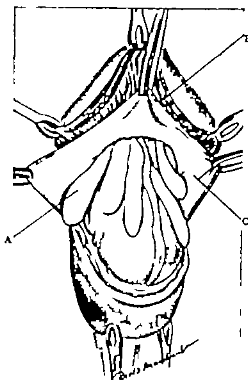


Fig. 544—Peritoneum opened and divided. Note (A) fatty appendices epiploicæ (B) layers of rectal cuff (C) peritoneum.

The visceral peritoneum on either side of the mesocolon is now incised the individual vessels are defined and securely ligatured since after division the mesocolon may retract out of sight.

During this procedure further portions of the undivided posterior half of the rectum are divided in stages

The remainder of the colon is now divided obliquely in order to leave a slightly longer cuff posteriorly and a guide suture is inserted in the midline posteriorly (*See* inset Fig 546) The anastomosis is completed by further interrupted sutures through all layers of the bowel. (Fig 547)

The excised rectum is an important receptor organ in the reflex mechanism of defæcation (Gaston) the anal canal musculature is poor and the anus patulous in these cases and finally only the apex of the peritoneal sac of the sliding hernia is excised

The hernial sac can only be completely obliterated from above and as already mentioned this entails an abdominal operation of some magnitude

In order to improve the results and to ensure better rectal function it is suggested that the recto-sigmoidectomy operation be modified by leaving at least a 1½ to 2 in cuff of rectal wall in order to retain some sensation and that the operation be completed by a pubo-coccygeus lattice (reduction in size of *visceral pelvic aperture*) *or later* supplemented by a Thiersch s operation.

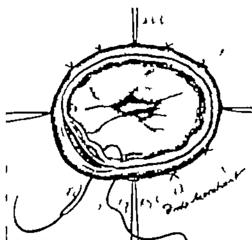


Fig 547 —The final sutures uniting the edges of the bowel.

Pubo-coccygeus lattice. Indications —1 An adjunct to recto-sigmoidectomy and carried out at the same time. 2 For a short complete prolapse (up to 2½ in)

When combined with rectosigmoidectomy and after the closure of the peritoneum the thick stout pubo-coccygei are identified by blunt dissection as they pass on either side of the vagina and rectum from their origins at the back of the pubis. The gap between these muscles below the sutured peritoneum is filled by constructing a lattice of nylon floss but the muscles should not be disturbed from their positions by any attempt to approximate them Usually about 8 ft of suture material will be required The operation of rectosigmoidectomy is then completed.

When this is the only method being used the patient is placed in the lithotomy position and the operation is performed through a transverse incision between the rectum and vagina.

The incision is deepened through the perineal body and the posterior vaginal wall dissected from the rectal wall The peritoneal pouch will be encountered and deliberately opened A better exposure may be obtained by dividing the whole posterior vaginal wall longitudinally as far as the posterior fornix

The pubo-coccygeus on either side is identified by stripping the peritoneum and fat from its medial surface The peritoneal pouch is closed as high as possible (level posterior fornix) and the lattice constructed without tension

The posterior vaginal wall is then repaired with catgut and the wound closed without drainage If there is excessive oozing the vagina is packed with flavine and paraffin gauze which should be removed within 24 hours

The patient should remain in bed for at least 14 days The bowels are encouraged to act after five days

Thiersch's operation.—This aims at surrounding the anus with a silver wire suture With the patient in the lithotomy position a small incision (½ in.) is made about 1 in posterior to the anal verge and a similar incision made in front of the anus

A curved handled Doyen's needle is introduced through the posterior incision and passed around the right side of the anus about ½ in from the anal canal deeply in the subcutaneous tissues and its point made to appear through the anterior incision

A 9-in length of silver wire No 20 S W G is threaded through the eye of the needle looped back on itself and withdrawn through the posterior incision and the needle removed. The needle is introduced in a similar manner on the left side and the anterior free end of wire is threaded into it and withdrawn around the anus to appear in the posterior incision

Care must be taken at all stages to prevent the wire coming into contact with the skin The two ends of the wire are now twisted together whilst an assistant gauges the degree of tightness with a forefinger in the anal canal. The circle of wire should just allow the whole forefinger to be passed comfortably

The twisted wire ends are now cut to about ½ in. and bent upwards and buried deeply in the subcutaneous fat.

Skin clips are used to close the incisions which are sealed with Whitehead's varnish.

The patient may get out of bed the following day and is given mild aperients A finger should be gently passed at intervals since during the post-operative period care must be taken to avoid fæcal impaction Patients usually leave hospital 7 to 10 days after the operation.

BENIGN TUMOURS

Adenomas and villous papillomas of the large bowel are premalignant conditions and therefore must be removed and always examined histologically Furthermore sigmoidoscopy and barium enema X ray should be carried out to exclude multiple tumours

Adenomata.—These tumours may be either pedunculated or sessile are red in colour and rarely become larger than a cherry Pedunculated polyps situated in the lower half of the rectum can under general or spinal anæsthesia be delivered through the anus by means of the finger and the pedicle ligated with stout silk and divided by cutting diathermy current

Pedunculated adenomas arising higher may occasionally be made to prolapse through the anus but are usually more easily removed through an operating sigmoidoscope using a Frankfeldt diathermy snare Sessile adenomas are treated by fulgurizing with a diathermy electrode through a large proctoscope or operating sigmoidoscope A

fairly low cutting current is used in all cases to produce a minimum degree of tissue destruction Adenomas situated in the anterior rectal wall above the peritoneal reflection should be treated with greater caution owing to the risk of perforation of the rectum. It is safer to deal with such cases in two or more sessions at fortnightly intervals.

Early malignant change in an innocent adenoma.—Where early malignant change has occurred careful serial section of the mucosal pedicle or margin is necessary Should malignant cells be present in the pedicle or removal of a sessile tumour be incomplete further treatment will depend upon the site of the tumour In the rare instance of the malignant cells being anaplastic a combined excision will be necessary When the growth is below the peritoneal reflection and within easy reach of the finger thorough fulguration with the dia thermy of the site of the removed tumour should be carried out

It is essential to keep such cases under regular and careful observa tion for several years and by palpation and endoscopy to detect any thickening or breach of surface A malignant recurrence will require a combined excision of the rectum

When the growth is situated high in the rectum above the peritoneal reflection its site cannot be felt and diathermy of its base is dangerous owing to risk of perforation. Such cases should be treated by a restorative resection.

Villous papillomata.—These tumours spread diffusely but slowly in the mucosa are soft and spongy and may reach a great size. The limits of these tumours are not always easy to define since they fade gradually into the normal mucous membrane. It is wise to assess their extent by examination under anæsthesia before embarking on treatment

Villous papillomata of small or medium size arising in the lower part of the rectum can usually be delivered through the anus by traction upon the normal surrounding mucous membrane at their base with sponge-holding forceps An artificial pedicle is thus produced which should be ligatured by Goodsall s method. A fringe of normal mucosa must be removed with the tumour Traction directly upon the papilloma is inadvisable because of its extreme friability

Sometimes such a papilloma can be excised through the anus by submucous resection with or without suture of the mucous membrane.

A papilloma of similar size in the upper part of the rectum is removed piecemeal through an operating sigmoidoscope by means of the diathermy snare and finally fulguration of its broad base This may require several sessions. When part of the tumour is pedunculated and the remainder sessile the pedunculated areas should be removed with the diathermy snare before fulgurizing the sessile portion

A villous tumour has an apparent tendency to recur but no doubt this is probably due to incomplete removal owing to the difficulty

of accurately defining its edge. These cases must therefore be very closely followed up and it should be remembered that 10 per cent of rectal carcinomata arise in pre-existing villous tumours An indurated area in the soft spongy growth usually indicates malignant change If the case presents any difficulty as regards satisfactory and complete local excision then resection or excision of the bowel must be carried out Large villous tumours owing to their size cannot be adequately dealt with by local excision When situated on the lower third of the rectum an abdomino-anal excision should be contemplated for such growths

Should the lesion extend to the anal canal a combined excision or in a suitable case submucous resection of the tumour bearing mucosa, followed by telescoping the divided distal end of the pelvic colon through the denuded rectal cuff may be employed

In the upper half of the rectum large villous tumours should be treated by restorative resection

Familial polyposis.—There are three methods commonly employed for dealing with this fortunately rare but distressing condition

(1) Complete removal of the whole colon and rectum leaving the patient with a terminal ileostomy This is called for when malignant change has occurred in the rectum Apart from the inconvenience of wearing a suitable apparatus to collect the semi fluid motions an ileostomy is however not entirely free from complications

(2) The mucosa of the rectum may be removed submucously and the ileum drawn through the rectal muscle cuff and sutured to the anal canal as suggested by Ravitsch In past experience this operation is unsatisfactory since the patient usually has very poor or no control.

(3) It is possible in most cases to remove the adenomata from the rectum by fulguration with the diathermy All the polypi should be removed to a distance of 15 cm commencing at the upper limit and progressively working downwards until all the adenomata are destroyed This will require weekly diathermy removal until the rectum is cleared

The whole colon may now be resected in one stage and an ileo-rectal anastomosis made below the uppermost margin cleared of polyps This leaves a rectal stump which can be palpated and examined by direct vision through a sigmoidoscope. This examination must be undertaken regularly every three months and later at six monthly intervals This method recommended by Lockhart Mummery has been successfully carried out in a number of cases These patients have two to four bowel movements each 24 hours but have normal and complete control It will be found that further polyps do not appear to grow in the rectal stump so vigorously owing to the presence of ileal contents and provided regular follow up examinations are made this would appear to be the best operation since rectal function is unimpaired

CANCER OF THE RECTUM AND RECTOSIGMOID

It has been estimated that about 10 per cent. of all malignant tumours occur in this area. If the stomach be excluded this is the commonest site for malignant growths of the intestinal tract (80 per cent.) These tumours are more common in the male in proportion of about 2 to 1 and most frequently occur in the fifth decade but no age group is exempt. By far the commonest malignant tumour in this region is an adeno-carcinoma usually arising in a pre-existing adenoma and multiple tumours are not infrequent (approximately 4 per cent)

Spread.—A rectal carcinoma spreads in a centrifugal manner but extension is more rapid in the transverse axis of the lumen than it is longitudinally As the tumour grows it begins to ulcerate in the centre spreading through the bowel wall to the extra rectal tissues It has been shown by Dukes that it is rare for lymph glands to become involved until the perirectal tissues are invaded but venous involvement may occur at any stage especially in anaplastic tumours A practical and useful classification has been devised at St Mark s Hospital by Dr Cuthbert Dukes which enables the various operative methods to be fairly compared and prognosis assessed.

St. Mark s Hospital classifications.—Stage 1 (A Cases) are those in which the growth is limited to the rectal wall. Usually the growth is proliferative and of low grade malignancy (15 per cent)

Stage 2 (B Cases) are those in which the growth has spread by direct continuity into the extra rectal tissues (35 per cent)

Stage 3 (C Cases) are those in which the regional lymph glands are involved (50 per cent)

Stage 4. These are cases with metastases in the liver metastases in the abdominal lymph glands beyond the operation field general peritoneal metastases or deposits elsewhere.

Lymphatic spread.—The most constant direction of lymphatic spread is upwards along superior hæmorrhoidal and inferior mesenteric vascular pedicle and extension in other directions is unusual except in advanced or anaplastic growths Downward spread in the submucosal lymphatics is very slight (a few millimetres) Lymphatic spread below the growth was found by Dukes in 6 5 per cent of specimens but this occurred in only 2 per cent for distances of more than 2 cm Dukes estimates that three-quarters of the cases with downward spread are of high grade malignancy

Lateral spread.—It is known that the prognosis for subperitoneal growths especially when glands are involved is not as good as for similar growths lying above the peritoneal reflection It is probable that lateral spread occurs earlier in these cases owing to the proximity of the parietal pelvic fascia (lateral ligaments) containing the middle hæmorrhoidal vessels the enveloping visceral pelvic fascia and levator ani muscles and adjacent organs such as the prostate and vagina

Venous spread—This occurs in 15 to 17 per cent of cases but fortunately this finding does not necessarily mean that metastasis to the liver has occurred The prognosis however is less favourable

Endoscopic biopsy—The diagnosis of a rectal tumour should always be confirmed by a biopsy in order to exclude the rare granulomata and further to obtain some information of the degree of differentiation

Operability—In order to assess the full extent of spread of the disease an exploratory laparotomy is necessary in almost all cases In only the few cases with clinical evidence of gross hepatic involvement ascites or distant metastases pulmonary or cerebral etc. is exploratory laparotomy unjustifiable

Exploratory laparotomy—At laparotomy the liver is first examined and when metastases are present the degree of involvement must be gauged Destruction of not more than one-half of its substance should be no bar to a palliative removal of the primary growth Such patients will be made much more comfortable for the remaining span of life The whole colon is next thoroughly palpated to exclude the presence of a second primary tumour The finding of an associated carcinoma in the colon will alter the plan of operation

The presence of extensive secondary deposits in the peritoneum and omentum will preclude removal of the primary growth Peritoneal deposits localized to the vicinity of the growth will demand an extra wide excision of peritoneum though the prognosis in these cases is poor

Finally the aortic glands vascular pedicle and primary growth are examined If the case is otherwise favourable it may be justifiable to remove involved aortic lymph nodes *en bloc*

When the primary growth is fixed the only means of deciding upon its resectability is by a trial dissection upon the fixed aspects of the growth Many tumours apparently considered to be fixed on clinical examination will be found to be removable Fixity of the growth is often the result of perirectal inflammation which will only become apparent as the result of trial dissection

Owing to the magnitude of the radical operative procedures for cancer of the rectum a few patients such as those suffering from advanced cardiac renal or pulmonary disease may be found to be unsuitable for operation but the co-operation of a physician acquainted with major surgical problems will be of great assistance in arriving at a decision.

It should always be borne in mind that the terminal stages of a patient with an unremoved carcinoma are so distressing that every effort should be made to excise the primary tumour

Many cases hitherto considered inoperable can now be treated by excision As the result of careful and thorough preparation by the employment of bolder methods made possible by the use of the Lithotomy Trendelenburg position (Lloyd Davies 1939) when two

surgeons can at the same time perform the perineal and abdominal portions of a combined excision and sometimes by performing a two-stage operation the operability rate (resectability rate) at St Mark s Hospital has reached 96 per cent.

Choice of operation.—The interests of patients suffering from malignant disease of the rectum will be best served if the surgeon considers which operation is particularly suited to the case rather than if he endeavours to make some one operation fit every variety of pathological or other circumstance. The age sex and the build of the patient as well as the site and the type of neoplasm may all have an influence on the selection

Since it has been established that lymphatic spread of carcinoma is mainly in an upward direction for any operation to be radical extensive removal of this upward field of extension is necessary Combined excision is the most radical method However because of the relatively rare incidence of downward spread, restorative operations obviating a colostomy must be considered in suitable and very carefully selected cases The advent of the sulphonamides and the antibiotic drugs and the advances in pre- and post-operative treatment and anæsthesia have made all abdominal operations safer

Less severe operations such as perineal excision with colostomy or an extended Hartmann s operation (anterior resection and colostomy) have still a small place in the treatment of cancer of the rectum either as palliative procedures or for the small group of patients with neoplasms at suitable sites whose general condition build etc will not allow of more extensive operations.

OPERATIONS FOR CARCINOMA OF THE RECTUM

1 **Combined excision**
   (a) Synchronous excision.
   (b) Abdomino-perineal excision
   (c) Perineo-abdominal excision.

2 **Restorative resection**
   (a) Anterior resection with intrapelvic anastomosis
   (b) Pull through operations (1) Abdomino-anal (2) procto-sigmoidectomy

3 **Perineal or posterior excision with colostomy**

4 **Abdominal or anterior excision with colostomy**

Preparation of the patient.—Perhaps the greatest advance in abdominal surgery in the past twenty five years has been the general adoption of careful pre- and post-operative treatment This is particularly the case in the surgery of malignant disease of the gastro-intestinal tract.

The patient should be admitted to hospital at least five days before operation In addition to a thorough physical examination which includes blood pressure recordings cardiac response to exercise and

occasionally electro-cardiography the chest should be X rayed and any bronchial irritation and infection treated. Laboratory investigations including blood count blood group blood urea estimation and chemical and bacteriological examinations of the urine, should be done. Plasma protein and chloride estimations will also give useful information. Where possible the bowel is cleared by mild aperients such as magnesium hydroxide and liquid paraffin and by daily enemata or high colonic lavage

All aperients are stopped at least 24 hours before operation and a final enema or rectal lavage given on the evening before operation it is unwise to give any rectal lavage on the operation day If a constricting growth is present decompression may be aided by the passage of a rectal tube guided through the growth either by the finger or through a sigmoidoscope. When adequate decompression is not obtained then and then only is a preliminary colostomy advised The use of intestinal sulphonamides and suitable antibiotics are of the greatest value and are given for five days before operation. (Phthalylsulphathiazole 10 grms in 24 hours and for two pre-operative days oral streptomycin ½ grm twice daily) Bacterial counts of the fæces confirm beyond all doubt the potency of these drugs. It is important to give large doses of vitamin C and vitamin B Complex and also vitamin K before operation

The intake of fluids should be at least three litres per day and the diet high protein low residue with sugar

Secondary anæmia is treated by blood transfusion and the hæmoglobin should be at least 80 per cent before operation is contemplated Adequate sedation is essential especially in nervous subjects When a patient has associated prostatic obstruction it may be wiser to relieve this before embarking upon excision of the rectal carcinoma

Anæsthesia.—Omnopon gr $\frac{1}{3}$ scopolamine gr $\frac{1}{150}$ are given one hour before operation. Although spinal anæsthesia has been extensively used in the past preference is now given to other forms of anæsthesia owing to the fall of blood pressure with the former anæsthetic.

The patient is induced with Pentothal followed by gas and oxygen with either ether trilene or cyclopropane

Injection of a muscular relaxant produces relaxation equal to that of a spinal anæsthetic and small doses of these drugs may be administered at intervals throughout the operation at times when increased relaxation is required

An intravenous drip is always started before operation commences and is an essential part of the procedure

Immediately the patient is anæsthetized a catheter is passed just within the bladder which is then completely emptied by sustained manual compression above the pubes a spigot is inserted before the pressure is released in order to prevent air entering the empty bladder In the male the catheter is tied in and the penis and scrotum

strapped to the right thigh and groin. In the female the catheter is removed.

Combined excision.—This operation is best performed in one stage not only because the operation field is unimpaired by an established colostomy but also because in general the mortality rate is lower

There are three established methods of combined excision the abdomino-perineal (Miles) the perineo-abdominal (Grey Turner and

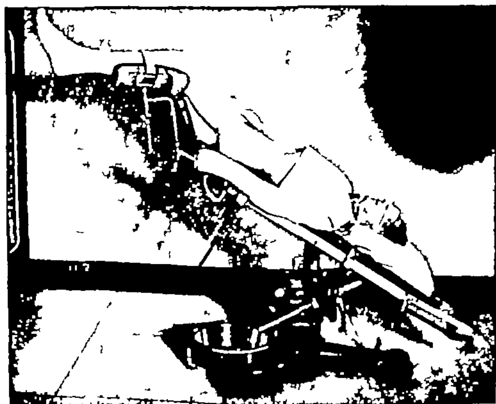


Fig 548 —Patient in Lithotomy Trendelenburg position, showing special leg supports and sacral rest.

Gabriel) and the synchronous method With the first two methods it is necessary to turn the patient between the abdominal and perineal stages

In synchronous combined excision special leg supports are used to place the patient in the Lithotomy Trendelenburg position and with the sacrum raised on a sacral rest or sand bag both the perineal and abdominal fields are easily accessible at the same time so that two surgeons can work together with little compromise or inconvenience to either Of course this position may be adopted by a surgeon working alone (Figs 548 549)

The advantages of this method are as follows —

1 In this position dissection of the perineal rectum is anatomically

easier than in the lateral position and the various portions of the levators with the pelvic fascial planes are seen with greater clarity

2 The turning of the patient during the operation of combined excision is injurious it looses time and produces a fall of blood pressure Time is spent in fixing the patient in the correct Lithotomy Trendelenburg position but all movement of the patient occurs before operation commences

3 Large fixed growths filling the pelvic outlet may be more readily mobilized and excision facilitated More accurate division of lateral

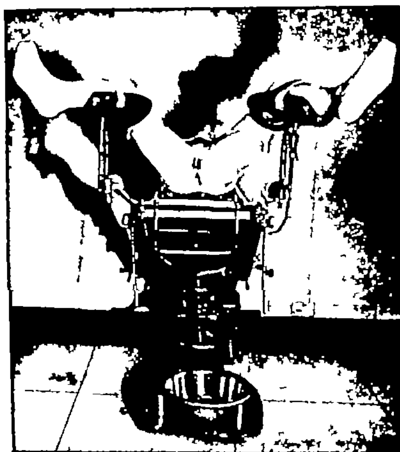


Fig 549 —Perineal view of Lithotomy Trendelenburg position the coccyx is marked by a dark triangle

ligaments especially when infiltrated with inflammation or growth is possible and this no man s land in the pelvis no longer exists

4 Should the ureters be involved it will be necessary for the abdominal surgeon to define them throughout their course in order to avoid injury in the depths of the pelvis This dissection absorbs time but meanwhile the perineal surgeon can go ahead Time is saved in advanced cases when resection and anastomosis of loops of intestine division of adhesions or hysterectomy etc is necessary since the perineal portion of the operation is being completed by the other surgeon

5 It is an advantage to close the peritoneal pelvic floor over an empty pelvis especially is this so in fat patients with a friable peritoneum This advantage is shared by perineo-abdominal excision.

6 The control of hæmorrhage is much easier since the bleeding point can be approached from two aspects

7 It is a safer operation for the less experienced surgeon and ideal for the training of young surgeons

8 An additional advantage of the position is that it is especially suitable for carrying out restorative procedures If during an attempt at a restorative operation there is troublesome hæmorrhage deterioration of the patient s condition or the blood supply of the proximal colon is found to be poor the plan can be quickly altered and a combined excision with colostomy expeditiously carried out For restorative resection such as abdomino-anal excision or a pull through operation of the Hochenegg type this position is an advantage since a surgeon working from the perineum can complete this phase of the procedure.

Synchronous combined excision. **The abdominal approach**.—The abdomen is opened through a long left or right paramedian incision which extends to the pubis The whole of the abdominal cavity is systematically explored, as already mentioned.

The situation of the rectal carcinoma in relation to the pelvic peritoneal pouch its size degree of perirectal infiltration or peritoneal involvement lymphatic spread and attachment to other organs is noted.

Though a growth may be apparently fixed and appear at first sight to be irremovable before making a final decision regarding inoperability a trial dissection upon its fixed aspects should be carried out As a rule the tumour can be freed from the sacrum in such cases and only when an anterior trial dissection has revealed that the bladder base or both ureters are grossly involved should the case be deemed inoperable Occasionally removal of the bladder and prostate with the rectum may be justifiable in which case the ureters will require transplantation Involvement of the uterus will necessitate a hysterectomy

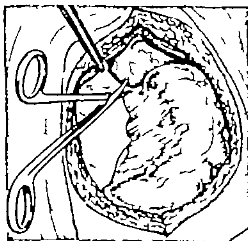


Fig 550.—Dissection of congenital peritoneal adhesions on outer side of pelvic colon.

The congenital adhesions on the outer side of the sigmoid loop are now carefully divided and the loop freed preserving the peritoneum of the left iliac fossa. (Fig 550)

The peritoneum of the left side of the base of the mesosigmoid is incised as it crosses the pelvic brim and the left ureter located and gently

swept away from the posterior aspect of the mesosigmoid to prevent its inclusion in the ligature of the vascular pedicle (Fig 551 A B)

The vascular arrangement in the mesosigmoid is now inspected and the point of ligation decided upon in relation to the blood supply

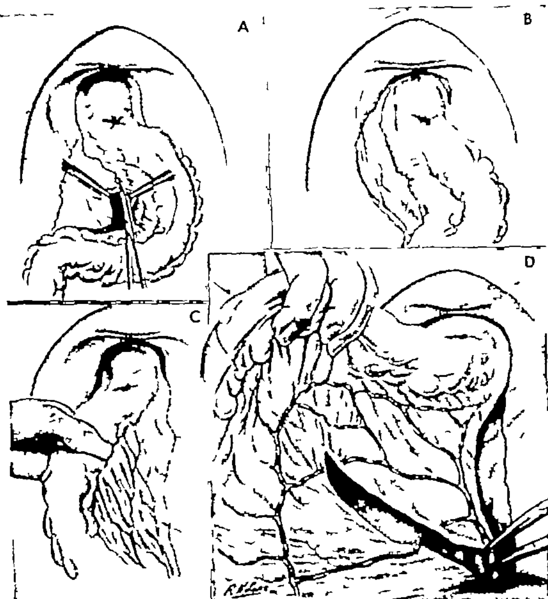


Fig 551 —Mobilization of the sigmoid colon, the mesosigmoid and rectum.

A Division of the peritoneum commenced on left side of mesosigmoid. B. Left ureter exposed—further division of peritoneum. C Showing extent of peritoneal division on right aspect of mesosigmoid. D. High division of the inferior mesenteric artery Left colic arterial bifurcation preserved. (The inferior mesenteric vein also ligatured and divided.)

of that portion of colon to be used for the terminal colostomy The vascular pedicle should be ligatured as high as possible to ensure the widest removal of the upward lymphatic field

The vascular pattern of the branches of the inferior mesenteric artery is variable In about half the cases it will be found that the

descending branch of the left colic artery will provide a good blood supply for the colostomy to be established in the uppermost portion of the sigmoid loop whilst in the remainder it may be necessary to retain the first sigmoid artery (In the former case if there be a good anastomosis from the middle colic artery the inferior mesenteric artery may be ligatured at its origin from the aorta.) (Fig 552)

The peritoneum on the right side of the base of the mesosigmoid is now incised from a point just below the level of the sacral promontory upwards to the point previously selected for ligature of the main vascular pedicle This pedicle is now divided between strong ligatures (Fig 551 C D)

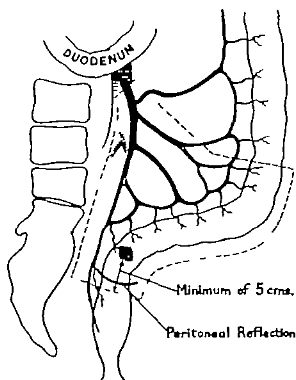


Fig 552 —Illustrating the desirable upward lymphatic and vascular field excised in both combined excision and restorative resection.

The pelvic dissection is next commenced by lifting forwards the rectosigmoid mesentery from the promontory of the sacrum and inserting a pair of blunt scissors downwards and backwards in front of the sacrum behind the mesorectum in the middle line. A presacral line of cleavage is thus produced and the fingers are now introduced into this space and the mesorectum deliberately separated and pushed forwards from the front of the sacrum and from the sides of the pelvis This separation is continued downwards to the coccyx and any tough strands of pelvic fascia are divided with scissors. At this stage the abdominal and perineal dissections join behind the mesorectum and the rectum is completely free posteriorly The hand is finally swept laterally on both sides to make prominent the lateral ligaments

The peritoneum and subperitoneal tissues are now incised on either side of the bowel as far down as the bottom of the peritoneal reflection

These two incisions are joined anteriorly just in front of the lowest part of the peritoneal pouch The base of the bladder and both vesicles or vaginal wall are now identified by dissection with blunt nosed scissors When the vesicles come into view they are completely defined as they extend laterally In so doing, the fascia of Devonvilliers has been incised and now a distinct line of cleavage extending as far downwards as the apex of the prostate will be found with the fingers In this space the fingers are again swept laterally to define the anterior

aspects of the lateral ligaments on either side In the female the vaginal vault is defined (Fig 553)

The lateral ligaments are next alternately placed on the stretch by retraction of the rectum to the opposite side by means of the left hand and divided the middle hæmorrhoidal arteries may require ligature If extra rectal spread or inflammation occurs into the lateral ligaments at this level the ureters must be defined and traced throughout their pelvic course to the bladder before the ligaments are divided. The abdominal dissection of the rectum is now complete and preparation is made to establish the terminal colostomy (Fig 554)

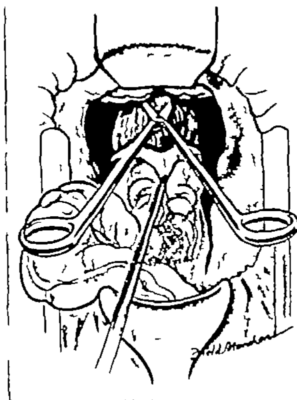


Fig 553 —Exposure of the vesicles by dissection from the abdomen.

The colon is prepared for division at the point originally selected by dividing the arcade of the first sigmoid artery and cutting the mesentery at right angles to the bowel.

At a point about 2 in along the line from the left anterior superior iliac spine to the umbilicus the skin of the abdominal wall is picked up and a small circular portion about an inch in diameter excised and a stab incision made through the abdominal wall The sharp edges of the external oblique are divided transversely to avoid constriction of the bowel.

The left edge of the laparotomy wound is retracted laterally to expose the paracolic gutter at the level of the stab incision In order

to obliterate the space on the outer side of the colostomy and prevent obstruction of small gut through this narrow foramen a purse string silk suture is inserted from the lateral peritoneal edge of the stab wound and continued across the peritoneum of the paracolic gutter to the mesenteric border of the colon. The ends are now tied together so obliterating the space lateral to the colostomy It is best to pick up a small portion of the transversalis and internal oblique at the lateral edge of the stab wound with the first bite of the needle in order to draw the colon securely up to the parietes Standing at

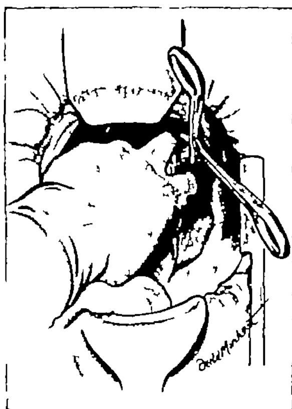


Fig 554.—Division of the upper parts of the lateral ligaments from the abdomen.

the right side of the patient will facilitate closure of the lateral space (Fig 555) The blades of a Parker Kerr forceps are now passed through the stab wound and the colon clamped at the site for colostomy Another forceps is placed on the colon distally and the bowel divided. *Aseptic caps are applied over each Parker Kerr forceps and proximal* bowel withdrawn through the stab wound. The distal colon and rectum are removed through either the perineal or abdominal incision. When pelvic hæmostasis is complete the peritoneum on the lateral pelvic walls is mobilized and the peritoneal pelvic floor closed over the empty pelvis In order to diminish the chance of adhesion formation, the edges of the peritoneum should be invaginated by a continuous Lembert suture and the main pedicle ligature covered. (Fig 556)

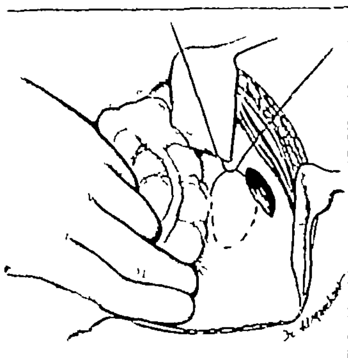


Fig 555.—Closure of the lateral space.
(From Brit. J Surg)

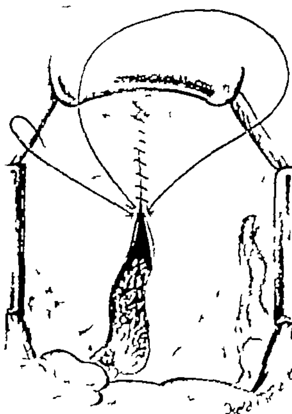


Fig 556 —Closing the peritoneal pelvic floor
(From Brit. J Surg)

The suture is continued outwards joining the free edge of the divided mesocolon and the edge of the peritoneum of the left iliac fossa as far as the point of exit of the colon. The abdomen is closed without drainage

The stab of incision must fit the emerging colon snugly just allowing the passage of one finger alongside it The mesentery is ligated immediately proximal to the clamp holding the colon and a glass rod then inserted through the mesocolon proximal to this ligature to prevent retraction of the bowel The abdominal wounds are now sealed with Whitehead s varnish dressings applied and the clamp removed. At least 2 in of colon should project above the anterior abdominal wall and if the bowel be loaded a Paul s tube should be inserted.

Alternatively the edges of the colonic stoma may be sutured carefully to the skin but the colon must on no account be divided flush with the abdominal wall. As the edges of the 2 in. projection of the colon are sutured to the skin its wall becomes everted making a very satisfactory stoma.

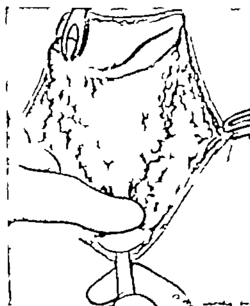


Fig 557 —Opening of a coccygeal joint preliminary to removal of the coccyx.

Perineal approach —The anus is closed with a subcutaneous purse-string suture of stout silk before the abdomen is opened to prevent soiling

The perineal dissection must not be commenced until the abdominal surgeon has explored the abdomen assessed the operability of the growth and the method of its eradication.

A transverse incision 1½ to 2 in. in length is made in front of the anus midway between it and the urethral bulb Further incisions are extended backwards from its extremity through the skin overlying the ischio-rectal fossa on either side of the anus to meet over the sacro-coccygeal articulation

These incisions are deepened through the finely granular fat of the perianal space until the lobulated avascular fat of the ischio-rectal space is seen and the coccyx exposed

A portion of the coccyx may or may not be excised but the dissection is in general facilitated by its removal Removal is aided by flexion of the coccyx in order to open up a coccygeal joint into which the point of the knife is inserted The knife should be kept close to the superior surface of the bone The dense fascia of Waldeyer will now be seen lying in the bed of the excised coccyx The middle sacral vessels may require ligature (Fig 557)

Small lateral incisions are now made on either side of the divided coccyx outwards through the fibrous attachment of the coccygeus muscles This enables the finger to be inserted on each side to separate the ilio-coccygeus muscles from the underlying fascia of Waldeyer In this plane the index finger passes forwards and outwards and re-enters the ischio-rectal space between the anterior border of the ilio-coccygeus and the superior border of the pubo-coccygeus The ilio-coccygeus muscles and overlying fat are now divided on either side with blunt nosed scissors well out on the lateral walls of the pelvis The inferior hæmorrhoidal vessels will require ligature. (Fig 558)

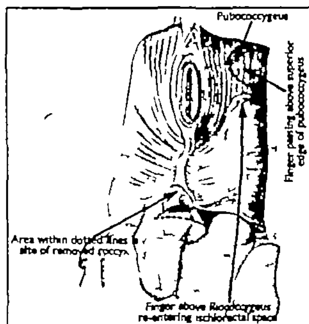
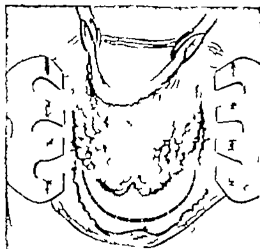


Fig 558 —Perineal dissection—following removal of a portion of the coccyx, index finger inserted under coccygeus and ilio-coccygeus before their division.

A self retaining perineal retractor (St Mark s) is placed in position and the fascia of Waldeyer incised just in front of the divided coccyx and the mesorectal fat will then be seen to protrude. The fascia of Waldeyer is next divided laterally at the level of the bony pelvic outlet and the fingers now can safely separate the mesorectum from the front and sides of the bony pelvis as far as the level of the sacral promontory in an average case At this stage the two operators meet behind the mesorectum on the front of the sacrum (Fig 559)


Fig 559 —Diagram showing the line of division of fascia of Waldeyer

The anterior part of the dissection is now continued and traction is made on a pair of tissue forceps holding the isolated perineal skin in front of the anus The transverse perineal muscles are sought on either side The plane of dissection is kept closely behind these muscles to avoid injury to the urethra In the middle line the decussating fibres of the external sphincter muscles are divided as they pass forwards to the central point of the perineum until the whole extent of the transverse perineal muscles is exposed. The whitish fibres of the longitudinal muscle of the anterior rectal wall will now be seen

The broad strap-like pubo-coccygeus muscle lying above the transverse perineal muscles on either side will now be found closely embracing the sides of the rectum and prostate or vagina.

A finger is inserted above the superior borders of the pubo-coccygei which are then almost completely divided from their origin (*See* Fig 557) The underlying layer of glistening visceral pelvic fascia will be seen ensheathing the lateral aspect of the mesorectum

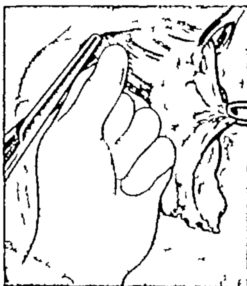


Fig 560.—Division of the right pubo-coccygeus muscle.

The lateral aspects of the prostate can now be easily palpated and the plane of the posterior aspect of the gland and the position of its apex assessed

The thick inferior borders of the pubo-coccygei (pubo rectalis) remain still undivided and hold the ano-rectal junction forwards in the middle line The borders of these muscles together with some longitudinal muscle fibres of the rectum which pass forward from the bowel to the posterior aspect of the membranous urethra and apex of the prostate (recto-urethralis muscle) form a tough fibromuscular barrier between the superior aspect of the transverse perineal muscles and the posterior aspect of the prostate This fibro-muscular barrier may be separated into two portions by blunt dissection in the middle line with an artery forceps. The forceps are directed towards the already located apex of the prostate and must lie parallel to the plane of the posterior aspect of the gland in order to avoid urethral injury (Fig 561)

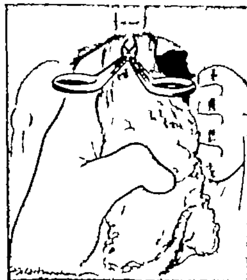


Fig 561 —Exposure of the apex of the prostate.

The fibro-muscular bundles thus isolated are each divided and the posterior surface of the greyish white fibrous capsule of the prostate is exposed. A few longitudinal fibres of the recto-urethralis occasionally obscure the prostatic capsule and must be divided in order to avoid injury to the rectum and expose the true plane of cleavage

The visceral pelvic fascia holding the lateral aspect of the prostate

to the rectum on each side is now divided and vessels lying in it will usually require ligation

The junction between the abdominal and perineal dissection has now been reached anteriorly

All that remains to be done to free the rectum completely is division of stout lower portions of the postero-laterally placed lateral ligaments if these have not already been divided from the abdomen (Fig 562)

If the specimen is to be delivered upwards into the abdomen the anus and lower rectum are enclosed within a glove Hæmostasis is secured and to avoid the risk of reactionary hæmorrhage it is important at this stage that the blood pressure be not much lower than the patient s normal

The perineal skin is sutured with vertical mattress sutures a corrugated rubber drain being inserted through the centre of the sutured wound. A rubber bag packed with gauze may be placed in the pelvic cavity when the peritoneal floor is high or very thin.

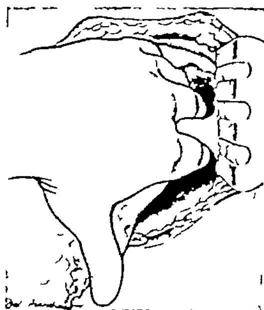


Fig 562 —Defining the lower portions of the left lateral ligaments by traction of the bowel to the opposite side before its division.

In the female the dissection is similar but when the growth is in the lower third of the rectum especially when situated anteriorly in apposition to the vagina, the whole posterior vaginal wall should be removed with the rectum No attempt at reconstruction of the vagina is made but the whole of the perineal skin incision is sutured reforming the vaginal orifice through which the perineal wound is drained

Abdomino-perineal excision.—In this operation the abdominal operation is exactly the same as that already described, but the dissection is carried down to the level of the fascia of Waldeyer from above Colostomy is established in a similar manner but the divided distal bowel held in a blade of a de Martel or Zachary-Cope clamp is pushed down into the pelvis and the peritoneal pelvic floor reconstructed above it. In order to obtain enough peritoneum to reconstruct the floor over the bulky bowel the peritoneum is mobilized extensively from the back of the bladder anteriorly and also laterally At the conclusion of the abdominal operation the patient is turned into the right lateral position and the perineal dissection commenced Following division of the fascia of Waldeyer the hand is passed between the mesorectum and the sacrum and the partially freed specimen grasped and delivered through the perineum By holding the divided bowel backwards the glistening posterior surface of the

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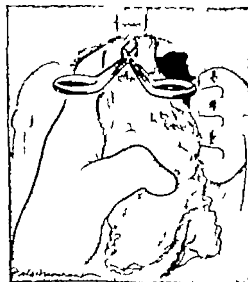


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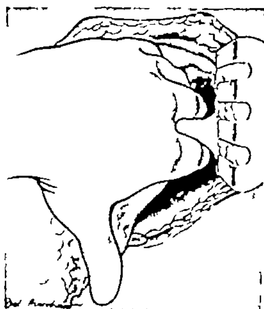


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prostatic capsule will be seen and the anterior dissection is quickly completed from above downwards by division of the stout visceral pelvic fascia the pubo-coccygei and the decussating fibres of the external sphincter at the central point of the perineum The peritoneal pelvic floor in these cases is high and the perineal cavity may require packing with gauze within a rubber bag

Perineo-abdominal excision.—This method is favoured by those experienced in perineal dissection of the rectum The abdomen is first explored through a right paramedian incision and then temporarily closed. The patient is then turned in the left lateral position for the perineal dissection The dissection is similar to that already described except that the whole of the lateral ligaments are divided from below and the peritoneal pouch is opened. When the upper border of the prostate is reached following division of the stout visceral pelvic fascia on either side of the borders of the prostate the vesicles should be identified. Occasionally the vesicles are covered by the stout posterior layer of Denonvilliers s fascia which in such cases requires incision to expose them The recto-vesical peritoneal pouch or pouch of Douglas found lying upon the anterior rectal wall is now opened at this level. The incision of the peritoneum is carried upwards for several inches on either side of the mesorectum into the pelvis The anal canal and anus are now enclosed within a rubber glove cleansed with saline solution and pushed upwards into the abdominal cavity Anteriorly the free edges of peritoneum are partially sutured from below with a continuous suture and the needle and catgut are wrapped in a small gauze swab for protection and later identification from the abdomen The perineal wound is closed with or without insertion of a rubber bag

The patient is now returned to the dorsal position with the table in a moderate Trendelenburg tilt. The abdominal wound is reopened and the bowel withdrawn from the pelvis and by further division of the lateral peritoneal incision upwards the rectum is freely delivered through the abdominal wound. The inferior mesenteric pedicle is next ligated.

A muscle splitting and cutting incision 3 to 4 in. long is made in the left iliac fossa. The lateral peritoneal space is closed through the iliac incision and the undivided bowel is delivered through this wound. The peritoneal pelvic floor is reconstructed over an empty pelvis utilizing the suture already commenced from below The paramedian incision is then closed. Finally the incision in the left iliac fossa is sutured snugly around the issuing colon tight enough to allow one finger to pass easily along the colon into the abdominal cavity A few interrupted sutures carefully placed between the peritoneum or internal oblique muscle and the colon prevent retraction Transverse incision across external oblique aponeurosis will prevent constriction at this level Both wounds are now sealed and dressed and the bowel is divided between clamps.

Restorative operations.—Certain criteria must be followed when restorative operations are contemplated Any operation for cancer of the rectum which aims at restoration of continuity must allow of removal of the same upward lymphatic field as would have been obtained by combined excision No approach from the perineum or through the sacrum alone can be in any way radical In addition the bowel below the lower edge of the growth must be divided at least 2 in distal to this point together with the whole mesorectum at this level (*See* Fig 552) In order to retain normal defæcation not only is preservation of the sphincter mechanism necessary but it is also necessary to preserve the sensitive lining of the anal canal

Restorative operations are best carried out in the Lithotomy Trendelenburg position to allow cleansing of the lumen of the bowel below the growth during the operation and also to permit of a change of plan without turning the patient Careful selection of cases is essential and the chances of complete extirpation must not be sacrificed for restoration of continuity unless there are distant metastases

A growth situated in the lower half of the rectum is in such close relationship to the fascial and muscular pelvic floor that any operation which leaves these structures *in situ* cannot be radical (*see* Fig 518) Furthermore the established fact that the prognosis for growths in this situation is poorer than for neoplasms situated above the peritoneal reflection demands the employment of an operation that allows of wide removal of these structures namely a combined excision.

The following are the main deciding factors to be considered —

1 *Site of growth* —The lower margin of the neoplasm must not be less than 10 cm (which is an arbitrary distance) from the anus and be above the peritoneal reflection The height of a neoplasm as estimated on sigmoidoscopy is often less than it appears owing to the rectal curves About one half of all cancers are unsuitable by reason of their position alone

2. *Size* —If a growth is bulky or there is evidence of marked extra rectal spread a combined excision is advised because of the increased risk of local recurrence which might involve the anastomosis or retained bowel Further a restorative operation is often very difficult under these circumstances and should not be attempted.

3 *Histology* —If there is either clinical or histological evidence that the growth is of the anaplastic simplex type combined excision should be performed.

4 *Build of the patient* —In a short fat subject with a small pelvis and short fat laden mesentery the operation is unwise and may be impossible

5 *The anatomy of the colon and its vascular arrangement* —The length of the mesentery and its vascular arrangement is always a factor in deciding upon an attempt at restoration of continuity Shortening of the colon mesentery due to fat or diverticulitis or

adhesions of the colon to the rectal growth will be limiting factors unless the transverse colon can be utilized

The most suitable case for restoration of continuity is one with a low grade small and early mobile growth situated well above the peritoneal pouch with no evidence of extra rectal spread The patient should not be obese and have a long mesosigmoid

As a palliative procedure for cases with distant secondaries restorative resection is ideal provided the primary growth is completely removed Under such circumstances some of the above-mentioned criteria may be disregarded

An additional word of warning is necessary with regard to cases treated by restorative operations It should be remembered that in about 4 per cent of all cases of neoplasm of the large intestine there is more than one primary tumour present and the possibility of their occurrence may be increased when portions of the rectum and sigmoid colon are retained

Careful search for a second primary tumour at operation has already been stressed and periodic follow up (six monthly) including regular sigmoidoscopy is imperative in all cases

Intrapelvic restorative resection (anterior resection and anastomosis).— The patient is placed in the Lithotomy Trendelenburg position and the abdomen opened through a long left paramedian incision

If the case is deemed suitable for a restorative resection one may find that decompression is incomplete and the colon preparation inadequate In such a case a colostomy should be performed in the transverse colon as far to the right as possible through a separate stab incision above and to the right of the umbilicus as a first stage However in the large majority of cases a one-stage resection operation is usually possible

The iliac and pelvic colon are mobilized as for a combined excision but the division of the lateral peritoneal fold on the outer side of the bowel may be extended with advantage as far upwards as the splenic flexure thus enabling the whole left colon to be drawn across to the middle line

The peritoneum on the left side of the pelvic brim is incised and the left ureter exposed and swept away from the base of mesosigmoid to avoid its inclusion in the main pedicle ligature

The vascular arrangement of the inferior mesenteric artery is now inspected and transillumination is often of assistance

Depending upon the size of the descending branch of the left colic artery the main inferior mesenteric trunk is divided as in a combined excision. It should be remembered that the left colic and first sigmoid arteries have a common origin in about half the cases

The sigmoid branches below the ligated inferior mesenteric vascular pedicle should now be divided just proximal to their arcades in order to obtain the maximum length of viable bowel

The rectosigmoid and rectum are next mobilized the peritoneum

and subperitoneal tissues divided on either side well away from the bowel, the incisions being carried downwards for somewhat more than 5 cm below the lower margin of the growth.

At 5 cm below the lower border of the growth, confirmed by measurement, the rectum is prepared for division by ligaturing the mesorectum containing the superior hæmorrhoidal vessels, isolating the muscular bowel wall and applying some form of a right angled or other exclusion clamp. Extensive division of the subperitoneal tissues below

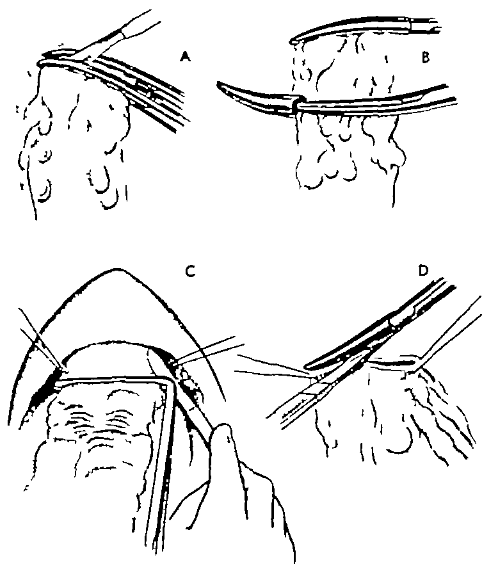


Fig 563.—Resection of growth, between clamps, with its lymphatic field.

A Proximal colon divided between clamps. B Divided ends of bowel protected by application of caps over cut ends. C Application of exclusion clamp at least 5 cm. below lower edge of growth. Rectal stump controlled by two stay sutures, rectum divided below clamp. D Crushed portion of proximal divided end removed by cutting off the clamp.

this level is generally inadvisable since small unnamed branches from the internal iliac arteries supplying the rectal stump will be sacrificed (Fig 563c).

Whilst the proximal colon is being prepared for division at the most suitable site an assistant irrigates the rectum below the exclusion clamp Irrigation is carried out through a proctoscope using two solutions Sodium bicarbonate and 1–500 Hydrarg Perchlor the object being to clean the bowel and especially to destroy any malignant cells lying free in the lumen which may become implanted in the suture line

When the bowel is clean the assistant removes all retained fluid with a sucker and dry swabs

The colon is divided at a point which will allow the anastomosis



Fig 564.—Method of end-to-end anastomosis.

A, Insertion of posterior row of interrupted silk seromuscular sutures. Note that the mesenteric edge of the proximal colon (X) is placed to the right. (It has been rotated through 90 degrees.) B, Continuous all-coats suture of catgut. C, Anterior portion of anastomosis being closed with continuous Connell stitches (If tube is to be passed through the anastomosis, it is inserted just before the anterior suture line is completed. D Interrupted seromuscular silk sutures inserted to complete anastomosis anteriorly

to be made without tension and at which the blood supply is completely adequate. In the average case this is 6 in. above the upper border

of the growth The colon is divided obliquely between crushing clamps (Fig 563A B)

The rectum distal to the right angled clamp is next secured with two laterally placed holding sutures of black silk or long tissue forceps and the bowel divided below the clamp Hæmostasis of the cut edge of the rectal stump is secured and its lumen again swabbed with the mercury solution

The crushing clamp on the end of the colon is now removed by division of the bowel close against the proximal surface of the clamp and the lumen cleansed with 1–500 Hydrarg Perchlor and if necessary enlarged by incising the anterior mesenteric border The only sure test of viability is arterial bleeding from the divided end of the bowel (Fig 563D)

A careful open end to-end anastomosis is performed in two layers the outer layer being of interrupted fine black silk sutures and the inner of a continuous all layer suture of No 0 chromic catgut on an atraumatic needle The greatest care must be taken to avoid eversion of the mucous membrane. (Fig 564A B)

Before the first anterior line of sutures is completed a soft œsophageal tube may be passed downwards and partially withdrawn from the anus by an assistant It is then pushed upwards for 8 to 12 in above the line of suture into the proximal colon and the anastomosis then completed. (Fig 564C D) The tube is sutured near the anus It is moved a little within 12 hours and withdrawn about 2 in twice daily

The bare areas on either side of the bowel are now reperitonealized and the main pedicle ligature covered When the anastomosis lies low in the pelvis the peritoneal floor is closed above it but a large subperitoneal space should not be left It will often be found that reperitonealization is unnecessary as the colon lies snugly against the lateral divided edges of the peritoneum

The posterior aspect of the anastomosis is drained with a strip of corrugated rubber which passes transperitoneally or retroperitoneally through a stab incision in the left iliac fossa.

If the anastomosis has been particularly difficult or when bowel preparation has not been entirely satisfactory a temporary colostomy in the proximal transverse colon is performed before the abdomen is closed. The two limbs of the colon are sutured together (double barrelled) and delivered through a separate stab incision The colostomy is opened after the abdominal wounds have been sealed and dressings applied. When in any doubt perform a concomitant transverse colostomy

In cases where the pelvic loop is too short it may be possible to anastomose the transverse colon or splenic flexure to the rectal stump If the transverse colon normally swings comfortably downwards for an inch or so below the umbilicus this is a feasible proposition and complete mobilization is obtained by dividing the phrenico-colic ligament and the gastro-colic omentum The left branch of the middle

colic artery is preserved This manœuvre should not be attempted when the transverse colon is placed high and has a short mesocolon.

Abdomino-anal resection.—This method is sometimes advised for very small early tumours of low grade malignancy situated just within reach of the finger and lying immediately below the peritoneal pelvic floor or as a palliative procedure As already mentioned the radical procedure for tumours lying in this position of the rectum is a combined excision

The method is only rarely used and requires a much longer loop of pelvic colon than would suffice for an intrapelvic anastomosis The operation is carried out in the Lithotomy Trendelenburg position. The main vascular pedicle and sigmoid arcades are dealt with in exactly the same way as in the previous operation The abdominal dissection of the rectum is continued down to the level of the apex of the prostate in front and beyond the tip of the coccyx behind as described in abdomino-perineal excision The lower end of the rectum down to the level of the ano-rectal ring is completely freed by division of surrounding strands of pelvic fascia A suitable right angled clamp is now applied about 2½ in above the anal orifice and the anal canal and lower cuff of rectum cleansed as mentioned in the intrapelvic resection operation When this is done the rectum is divided immediately below the clamp and the freed rectum delivered through the abdominal incision

From the perineum the anus is gently dilated the upper border of the cuff of rectum is grasped with several pairs of tissue forceps and gently everted through the anus This may often be conveniently accomplished by a trained assistant whilst the colon is being divided obliquely between clamps at its lowest point of viability The clamp on the proximal colon is passed down to the anus where the assistant secures the colon in tissue forceps The clamp is removed and the

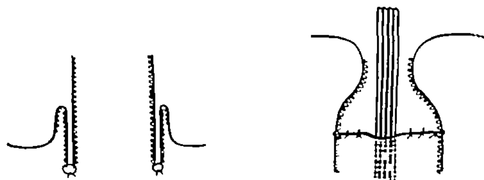


Fig 565.—Showing method of anastomosis and drainage of pre sacral space.

proximal end of the colon delivered through the anus Alternatively the open end of the colon may be passed through the anus by means of four guide sutures

The anastomosis is made between the everted rectal cuff and colon by means of interrupted No 2 chromic catgut sutures placed through

all layers as in a rectosigmoidectomy operation for prolapse Should there be insufficient viable bowel the operation can be terminated as an extended Hartmann's operation (*vide infra*) It is important to drain the presacral space and this is best accomplished by means of a strip of corrugated rubber drain passed through the posterior part of the suture line and withdrawn through the anus (Fig 565)

The peritoneal floor is now reconstituted to leave as much as possible of the pelvic colon within the peritoneal cavity Dead space below the peritoneal floor in which blood can collect should be avoided. In all cases a temporary transverse colostomy is performed through a separate incision at the end of this operation

Abdomino-sacral operation —The only difference between this operation and that of abdomino-anal excision is that the final stages of the isolation of the lower third of the rectum and the anastomosis are performed through an additional sacral or perineal incision The anastomosis may be one or two layered and the presacral space is drained through the posterior incision. Fistulæ between the anastomosis and the exterior commonly occur after this procedure and may take many months to close despite the presence of a transverse colostomy

Perineal excision (Lockhart Mummery) —This operation is carried out either in the left lateral or the lithotomy position This is generally a palliative procedure and is only used for growths in the lower third of the rectum in patients whose general condition will not warrant a radical combined excision A preliminary colostomy is performed 14 days before excision and the lower segment washed through daily Details of perineal dissection have already been fully described The peritoneal pouch is sought on the anterior rectal wall and opened and the rectum mobilized by division of the lateral ligaments from below The superior hæmorrhoidal vessels which lie close to the bowel wall are divided as high as possible and ligated. The semi lunar opening in the peritoneal pouch is now closed by continuous sutures which commence at each corner and terminate in the middle line The bowel is divided between two small crushing clamps about 1 in below the closed peritoneal floor and the proximal end of the bowel closed and invaginated by means of a Mikulicz stitch and if possible by a further purse-string suture. In order to diminish the chances of the troublesome mucous leak (perineal fistula) any redundant peritoneum below the sutured peritoneal floor should be stitched over the end of the closed rectum

The perineal skin is sutured with vertical mattress sutures and a small drain inserted through the middle of the wound

Hartmann's operation (anterior excision with colostomy) —This operation is rarely indicated and has been done in the past for growths at the rectosigmoid or in the upper half of the rectum in patients whose general condition would not permit of the added shock of a supplementary perineal dissection (combined excision)

After excision of the diseased portion of bowel and its mesentery the distal rectal stump is closed invaginated and the peritoneum reconstituted The proximal end of the colon is brought out as a colostomy through an incision on the left iliac fossa.

Growths in the above situations are now treated when circumstances permit, by restorative procedures

If when endeavouring to perform a restorative resection there is an insufficient amount of viable bowel to restore continuity or the patient s general condition deteriorates the operation may be terminated by the Hartmann method.

This operation may be extended downwards (extended Hartmann s operation) for growths situated lower in the rectum the bowel being divided at the level of the pelvic diaphragm.

For subperitoneal growths the extended Hartmann s operation is not as radical as for growths above the peritoneal reflection.

The essential steps for the removal of the rectum by this method have been described under combined excision and abdomino-anal resection.

After the removal of the bowel and the establishment of a terminal colostomy the peritoneal floor is reconstituted over the unclosed anal stump The subperitoneal space is drained through the anus after complete division of the ano-rectal ring through the anus from below

Colostomy in continuity (Loop Colostomy) —Temporary or preliminary colostomy indications (cancer of the rectum)

1 Acute large bowel obstruction.
2 Chronic obstruction unrelieved by non-operative measures.
3 Perforation vesicocolic fistula or pericolic abscess.
4 Performed concomitantly with resection and anastomosis when there is any doubt regarding the suture line etc. and is advisable in all cases of abdomino-anal or abdomino-sacral resection
5 In certain cases of growths with gross perirectal infection and œdema in order to improve the condition of the patient before excision

A temporary colostomy should always be made in the right half of the transverse colon well away from the field of the future operation This will allow complete mobilization of the left half of the colon should this be necessary at a second operation. A loop colostomy sited in the left iliac fossa will make adequate removal of the mesosigmoid lymphatic field difficult and will limit full exposure of the pelvis.

A 3-in incision is made through the middle of the right rectus muscle the centre of the wound being the 2 in above the level of the umbilicus The transverse colon is sought and withdrawn through the wound When possible the two limbs of the colon are sutured together (gunbarrelled) along their antimesenteric borders for about 3 in extending to within half an inch of the mesenteric edge of the bowel The great omentum is dissected upwards off the colonic loop

and the colon is drawn through a small hole made in this freed portion of the omentum which is then replaced into the abdomen A small glass rod is now passed under the apex of the loop through the transverse mesocolon and to secure the rod pieces of rubber tubing are fitted over its ends

The abdomen is closed in layers allowing sufficient room for a finger to be inserted comfortably alongside the loop of bowel and the parietes. The wound is protected with Whitehead's varnish and gauze dressings secured by waterproof adhesive strapping

The colostomy is opened in the operating theatre and in cases of acute obstruction a Paul's tube inserted

A well formed colostomy with a good spur completely isolates the distal bowel but it is wise to support the spur by retaining the glass rod or alternatively replacing it by rubber tubing until exclusion of the distal bowel is no longer necessary The rod or rubber tubing is usually left *in situ* for three weeks

Closure.—In order to prevent contraction at the site of the distal anastomosis the colostomy should be closed as soon as conditions permit Closure may be performed either extraperitoneally or intra peritoneally Suitable sulphonamides and antibiotics are given pre-operatively

Extraperitoneal closure—The rod or tubing is removed and a few days later a suitable enterotome applied to crush the spur A finger is passed into each limb of the colon and by palpation the absence of any intervening structure verified Frequently the colostomy opening will not admit two fingers in which event palpation is made between a closed artery forceps in one limb and a finger in the other The enterotome is now inserted and closed slowly and firmly to crush the whole spur The instrument will require tightening daily It is usually free in five to seven days When the spur has been removed fæces will pass onwards into the distal contracted colon and normal function is gradually restored. This is particularly of value when there has been a temporary colostomy of long duration When a reasonable proportion of the fæces have reached the rectum usually within a few days of removal of the enterotome the final stage of closure is carried out.

Under general anæsthesia the bowel is dissected free of the layers of the abdominal wall a fringe of skin being left on the bowel wall for purposes of traction. Complete mobilization of the colon down to the peritoneum is essential. The fringe of skin surrounding the stoma is now excised and the stoma closed by an invaginating suture of catgut placed transversely to the long axis of the bowel A second layer of interrupted seromuscular sutures is then inserted and the closed loop replaced below the muscular and aponeurotic layers of the abdominal wall Complete hæmostasis is secured and the abdominal wall then closed in layers leaving a very small drain down to the sutured gut The drain is removed in 48 hours

Intraperitoneal closure.—This method will be employed as an alternative to the previously described procedure and should always be used if the colon has not been gunbarrelled and there is no spur to crush or in cases of prolapse of the colostomy The colon is freed from the parietes including the peritoneum and the bowel is withdrawn from the peritoneal cavity which is then packed off After excising the skin and any oedematous mucosa surrounding the stoma, the opening is enlarged by incising the bowel along its longitudinal axis on either side sufficiently to allow an adequate lumen to be obtained The enlarged stoma is closed as already described and the abdomen closed in layers without drainage

Permanent loop colostomy *Indications*—1 Although a colostomy alone has little place in the palliative treatment of carcinoma of the rectum on rare occasions it may be indicated for intestinal obstruction in the presence of an inoperable and irresectable growth A permanent loop colostomy should always be established in the sigmoid colon when possible

2 As a preliminary operation 14 to 21 days before perineal excision. The operation is performed through a 8 in. muscle-splitting incision in the left iliac fossa at the junction of the outer and middle thirds of a line passing from the umbilicus to the anterior superior iliac spine The upper part of the sigmoid loop is withdrawn from the wound care being taken that it is not rotated. Mobilization of the loop may be necessary by dividing the congenital folds on its outer side The lateral space is closed by means of a purse-string suture of silk which underruns the parietal peritoneum of the paracolic gutter from the abdominal incision along the lateral leaf of the mesentery to the mesenteric edge of the colon.

A hole about half an inch in diameter is made in the mesosigmoid at the apex of the colon loop near the mesenteric border The peritoneum is closed around the limbs of the colon tight enough to allow the passage of a finger into the abdomen alongside the bowel This should be the degree of tightness of all layers of the abdominal wall around the colon The internal oblique and transversalis muscles are not sutured. Small transverse cuts are made across the fibres of the external oblique aponeurosis on either side of the colon to prevent undue contraction of its rigid edges on the bowel. This layer is repaired with interrupted catgut sutures which incorporate the internal oblique muscle to obviate the development of an interstitial hernia

To prevent any possibility of retraction of a permanent loop colostomy a bridge of skin is placed through the hole in the mesentery This is accomplished by fashioning a V-shaped flap of skin and subcutaneous tissue from the upper part of the lateral border of the incision leaving a broad base to the flap The apex of the flap is now passed through the hole in the mesentery A small incision is made through the skin and subcutaneous tissues at right angles to

the medial border of the skin incision large enough to accommodate the skin flap which is then sutured in position

In fat subjects the colostomy spur may be supported by using a flap from the external oblique aponeurosis passed through a smaller hole in the mesocolon in a similar manner

After dressings are applied the colostomy is at once opened as already described

Palliative curettage and fulgurization.—This procedure is useful for inoperable and stenosing growths in the lower third or ampulla of the rectum in order to decrease the amount of bloody mucous discharge and to increase the lumen of the bowel and postpone the need for a colostomy

After thorough curettage of the protuberant portion of the growth the whole of its surface is fulgurized through a large proctoscope or short operating sigmoidoscope using the coagulating diathermy current This manœuvre may require to be repeated on several occasions

Post-operative care **Combined excision** —Routine blood transfusion of about 500 c.c. of blood is given during the operation The usual post-operative treatment following a major abdominal operation is carried out and fluid by mouth is withheld until signs of returning gastro-intestinal motility are present. When the bowel sounds are heard two glycerine suppositories are inserted in the colostomy usually on the third day

Penicillin 1 000 000 units is given for four to five days post-operatively and in addition soluble sulphamethazine intramuscularly one grm eight hourly If streptomycin is used post-operatively it is usually discontinued within three days

The patient is encouraged to move about in bed as much as possible and is nursed on either side alternately pressure on the perineal wound being avoided

In the male the inserted urethral catheter is connected to a Dukes antiseptic drainage apparatus and the bladder emptied four hourly In the female the catheter is passed every eight hours The urethral catheter is usually removed on about the third to fifth day but catheterization may have to be continued for a longer period.

Apart from changing soaked dressings the perineal wound is not disturbed until the third day when the drain is removed and gentle irrigation of the perineal cavity with a mild antiseptic solution using a soft rubber catheter is commenced This is carried out twice daily

The perineal sutures are removed about the sixth day if the wound appears sound. A long piece of folded gauze soaked in a bland antiseptic solution is placed into the perineal cavity and directed upwards towards the front of the sacrum Every effort should be made to obtain healing from above downwards without pocketing and it is wise to inspect the healing cavity with the finger regularly after the first week.

The patient is generally out of bed on the fifth or sixth post operative day

Restorative resection. **Post-operative treatment as for a major abdominal operation** —As already stated if an œsophageal tube has been passed upwards from the anus through the anastomosis at operation this should be moved within twelve hours and further withdrawn an inch or so twice daily

The abdominal drainage tube is first moved on the third day and is gradually shortened daily until it is completely out about the seventh day

If flatus has not been passed per rectum by the fifth day and good peristaltic sounds are present a rectal tube is inserted into the rectum with very great care owing to the presence of anastomosis It is often possible to guide the tube with the finger through the anastomosis

During convalescence it is important to avoid fluid fæces and bulk forming substances are given together with a mild aperient in order to produce a firm stool which will aid in dilatation of the anastomosis

Before leaving the hospital the anastomosis should be inspected through a sigmoidoscope

CHAPTER XXV

RADIOTHERAPY IN MALIGNANT DISEASE

By B W WINDEYER

IN the treatment of malignant disease radiotherapy has at the present time an important and well established part to play There have been rapid developments in the technique in the accuracy and in the safety of treatment by this method so that in some instances cases which previously had not been thought suitable for radiotherapy are now being treated with success At the same time advances in surgical technique with the increased safety of many operative procedures have brought more types of malignant disease within the range of successful surgical removal.

There must be a continual assessment and reassessment of the relative value of surgery and of radiotherapy in the treatment of individual patients There are many who with our present knowledge are best treated by the use of some combination of surgery and radiotherapy Undoubtedly to obtain the best results and to ensure future progress it is necessary for the surgeon and the radiotherapist to work in the closest co-operation. It is therefore appropriate that in a surgical text book there should be some consideration of the use of radiotherapy and the problems associated with it.

Definition.—The term radiotherapy comprises treatment both by the use of X rays and by the radiations from radioactive substances In the past X ray therapy and treatment by radium or radon were considered to be two quite distinct forms of treatment They are however essentially the same. There are the same physical and biological problems and the same local and constitutional reactions from treatment In fact the development of X ray machines working at voltages of two million and higher has produced X rays which are identical with the gamma rays of radium

In addition to X rays and the naturally radioactive elements radium and radon there is now also the wide range of artificially radioactive substances some of which may be used as substitutes for radium and radon and others by new techniques involving ingestion injection into the blood stream or instillation into body cavities.

Equipment.—Adequate equipment for radiotherapy of malignant disease necessitates an organization which shall have available all these methods of producing radiations so that for each individual patient, the appropriate quality of ray and the most convenient method of application can be chosen

It is necessary to have a range of X ray machines working at different voltages Those working at low voltages of the order of

100 kilovolts or less produce X rays of relatively long wavelength which are absorbed in the more superficial tissues and are used for the treatment of non infiltrating lesions which are easily accessible. The higher the voltage the shorter is the average wavelength of the resultant X ray beam which on account of its greater penetrating power can be used in the treatment of more deeply seated growths X rays generated at 200 to 250 kilovolts have in the past been used for the treatment of a great variety of tumours in many situations. It has however not been possible with radiation of this quality to produce adequate dosage on deeply situated lesions The use of machines working at one or two million volts has now become routine practice and the clinical possibilities of the use of machines working at still higher voltage are now being explored

There must be an adequate supply of radium disposed in a variety of containers of different size and with different amounts of radium in each so that those which are most convenient to produce the appropriate distribution of radiation can be chosen for each individual case Radium may be used as a surface application in lesions on the skin It may be used by interstitial insertion into and around a growth deep in the tissues or it may be used by intra-cavitary insertion making use of one of the normal body cavities to apply the radium containers in close proximity to the lesion These containers are usually in the form of needles or tubes into which is packed the radium in the form of one of its insoluble salts radium sulphate or radium bromide The needles which have sharp points to enable their insertion into the tissues are made as small in calibre as possible consistent with strength so as to reduce trauma to a minimum

Radium tubes which are mostly used for surface applicators and for intra-cavitary applications are of larger calibre than radium needles and usually contain a greater quantity of radium per centimetre of active length of the tube The points are blunt and rounded as they are not required for insertion into the tissues The walls of the needles and tubes which are used for clinical work are usually of platinum at least 0 5 mm. in thickness This acts as a filter which absorbs almost all the beta rays and thus provides a source which is practically pure gamma radiation

Radon is mainly used in the form of seeds which in order to reduce the dangers of handling radon are now produced centrally at the Radiochemical Centre for the whole of the United Kingdom. The radon gas is enclosed in capillary gold tubing which is cut and sealed in various lengths The maximum length is 5 mm and the radon content or strength of the seed can be varied

In addition to the use of radium by surface interstitial and intra cavitary application the modern teleradium unit has been developed during the last twenty years and has now reached a high standard of efficiency as a method of treating certain localized malignant tumours particularly those in the region of the head and neck The teleradium unit consists of a heavy metal container in the centre of

which is placed a quantity of radium packed in tubes The walls of the metal unit are sufficiently thick to absorb the gamma radiation to an extent which will allow the unit to be manipulated with safety and applied to a patient without causing systemic radiation reactions In one wall of the container there is a gap through which emerges a canalized beam of gamma rays With appropriate suspension of the unit this gamma ray beam can be directed accurately to any desired point and treatment can thus be given by radium with the same essential technique as that used in X ray therapy The gamma ray beam can be directed safely and accurately to treat a tumour situated deep to the skin surface

Teleradium therapy demands large quantities of radium to the order of several grammes if an adequate depth dose is to be obtained and if the treatment time of each individual application is to be kept within reasonable bounds. The majority of the main radiotherapy centres in England have until recent years been using teleradium units containing up to 10 gm of radium but the radium in many of them is now being replaced by sources of radioactive cobalt

The availability of radioactive isotopes has provided new techniques by which radiotherapy can be used Some of them such as radioactive cobalt and radioactive tantalum wire have been found to be efficient and convenient substitutes for radium in the established surface interstitial and intra-cavitary techniques Radioactive strontium gold and phosphorus have been found useful as substitutes for beta ray applicators Colloidal solutions of radioactive gold are used for instillation into the pleural and peritoneal cavities in some cases of malignant effusion and radioactive bromine and sodium in solution are inserted in special containers into the bladder to provide homogeneous irradiation of the whole of the mucosa.

Great hopes were entertained of the possible therapeutic use of some short lived radioactive isotopes by their differential absorption in certain tissues and organs after their administration either intravenously or by mouth Their use in this way has so far largely proved disappointing with the exception of radioactive phosphorus and radioactive iodine The degree of selective absorption of phosphorus and iodine makes possible the use of their radioactive isotopes both by injection and by ingestion for treatment of diseases of the hæmopoietic system and the thyroid respectively

Some of the gamma emitting isotopes of long life such as cobalt iridium and cæsium are particularly suitable for use in teletherapy units They can be obtained in quantity and are much less costly than radium A high specific activity can be achieved and with radioactive cobalt it has been possible to construct units sufficiently compact to be easily manœuvrable and adjustable and which have sufficient protection to contain up to 1 000 curies and more the equivalent of 1 500 gm of radium This development has provided a simplified apparatus which is the equivalent for clinical radiotherapy of an X ray machine of 8 million volts

Mode of action —The mode of action of radiations on living tissues has been the subject of a great volume of experimental work from which many essential facts have been established but there is not yet any clear conception of all the processes which are involved. It is however certain that the action on all living tissues is an inhibitory damaging or destructive one depending on the size of the dose which is delivered. It has been argued that there is a stimulating effect and that in particular malignant growths may sometimes be stimulated by radiotherapy to more rapid increase in size. The evidence obtained from experimental work is that there is no basis for this contention and the cases where apparent stimulation has been observed clinically are almost certainly due to reactions of the tissues to the trauma inflicted by irradiation There may be for example an initial swelling of an irradiated tumour due to œdema and vasodilation

RADIOSENSITIVITY

All living tissues can be damaged or destroyed if a sufficient dose of radiation is given. Some tissues however are more sensitive than others and can be destroyed by doses which are insufficient to cause any permanent clinical effect on other more resistant tissues in the immediate neighbourhood

There is in fact a selective destructive effect and it is this selectivity which is the basis of all radiotherapy and which differentiates it from other methods of local treatment such as the cautery and electrocoagulation which are used to produce a diffuse and unselective destruction of tissues

There are marked differences in the dosage which different normal cells and tissues in the body will tolerate. Lymphocytes and lymphoid tissue are among the most sensitive and are easily destroyed by moderate dosage Epithelial cells are somewhat less sensitive and connective tissue muscle bone and nerve cells have increasing degrees of resistance As a general rule but one to which there are many exceptions tissues which are most rapidly growing and which have least functional differentiation are the most sensitive to irradiation.

The selective effect is also seen in the response to irradiation of various malignant neoplasms Some composed of sensitive cells are easily destroyed by relatively small doses others may need for their destruction doses of such magnitude that all normal surrounding tissues would undergo necrosis In between these extremes there are tumours of varying degrees of sensitivity

The variations in degree of tolerance to irradiation of different normal and malignant tissues determine the radiosensitivity of individual neoplasms On radiosensitivity depends the success or failure of radiotherapy A markedly radiosensitive growth is one which can be destroyed by dosage which is insufficient to cause any permanent clinical effect on the surrounding normal tissues. A

growth of moderate radiosensitivity is one in which the dose necessary for its destruction is the maximum that the normal tissues will tolerate and a radioresistant growth is one which is equally or more resistant to irradiation than the normal tissues in which it is situated

Factors affecting radiosensitivity—There are numerous factors which may influence radiosensitivity

(*a*) *Cell type*—The type of cell of which the tumour is composed is of the greatest importance

(*b*) *Mitotic activity*—Cells have their greatest degree of sensitivity during the process of mitosis and it was for some time believed that tumours with a high proportion of mitotic figures were more sensitive than others with a smaller proportion One of the effects of irradiation is however to alter the mitotic rhythm and although tumours with many mitotic figures present may show a more rapid initial regression it has not been found that the state of mitotic activity has great influence on true radiosensitivity and it cannot be used to forecast a different prognosis in tumours of the same cell type

(*c*) *Blood supply*—The quality of the blood supply is an important factor in determining the radiosensitivity of tumours Patients who are anæmic do not respond so well and if possible should have their anæmia corrected before radiotherapy is commenced. The state of the local blood supply is of even greater importance Any diminution in the normal vascularity of a tumour will tend to increase its radioresistance Syphilitic infection by increasing fibrosis and diminishing blood supply considerably lessens the degree of radiosensitivity A carcinoma of the tongue arising in an area of chronic syphilitic glossitis needs higher dosage to destroy the neoplasm and the normal tissues are mote liable to undergo necrosis Tumours arising in scar tissue either as a result of previous operation of burns or of lupus behave in similar fashion The effect of local bacterial infection is a similar one Infected growths are more radioresistant and at the same time heavy irradiation of infected tissues is likely to cause exacerbation of infection followed by widespread necrosis

(*d*) *Previous irradiation*—Recurrence after previous irradiation is always more resistant than the original tumour Not only is there the effect of diminution of blood supply by increased fibrosis but the cells of the tumour develop an inherent radioresistance which can be appreciated if the tumour spreads beyond the area previously treated to invade tissues with a normal blood supply

(*e*) *Tumour volume*—The size of the tumour and the volume of tissue which must be irradiated are other factors which influence radiosensitivity Small lesions are usually more sensitive than large ones This is not due to difficulty in obtaining adequate and homogeneous distribution of dosage throughout the larger volume but is probably due to the fact that in a tumour of considerable volume a much smaller proportion of it is in close proximity to the normal tissues of the tumour bed than is the case in a small lesion It is

more difficult for the round celled infiltration and phagocytic action which appear to be essential for the final destruction of the majority of neoplasms to take place throughout the whole tumour volume.

(*f*) *Anatomical situation*.—The anatomical situation and type of tissue in which a tumour grows have some influence on radiosensitivity An epithelioma of the lip is more radiosensitive than is a metastasis in cervical glands from the same tumour A cancer of the mouth is much less radiosensitive if it invades the bone of the mandible and a squamous epithelioma of the vulva is less radiosensitive than a growth of similar histological appearance occurring in the lip

(*g*) *Macroscopical type*.—The macroscopical type of growth is of some importance In tumours of the same histological variety exuberant and hypertrophic growths are generally the most sensitive Sclerosing lesions are generally the most resistant and ulcerating ones are intermediate in their response These factors of anatomical situation and macroscopic type are probably dependent on those of local blood supply and tumour bed reaction

(*h*) *Age*.—In addition to these factors which affect the radiosensitivity of tumours there are others which affect the sensitivity of the tissues as a whole After attaining adult age there is little variation attributable to age in the dose which will be tolerated but children have a much greater sensitivity A child aged one year will tolerate only about one-third and a child aged seven about two-thirds of the adult tolerance dose.

(*i*) *Pathological conditions*.—Certain pathological conditions such as thyrotoxicosis and diabetes increase the sensitivity and lower the tolerance of the tissues to irradiation Eczema and psoriasis make the skin more sensitive and chemical irritants such as iodine and mercury have a profound similar effect.

Radiation technique.—The technique by which radiation is delivered in the treatment of malignant disease is of major importance in its effect on radiosensitivity

(*a*) *Quality*.—The quality of radiation used is of obvious importance on account of the greater depth dose which is achieved by using a shorter and harder quality of ray and for this reason a softer radiation of longer wavelength may be chosen for the treatment of superficially situated lesions and a harder type of radiation of shorter wavelength for more deeply seated tumours It is still a controversial question whether there is any selective effect due to shorter wavelength radiation The question is raised particularly whether there is any selective effect which may make the short gamma rays of radium a more effective agent than the longer wavelengths of X rays in the commonly used 200–250 kilovolt range There are so many additional factors concerned that it is difficult to make a comparison between the two forms of radiation with regard to wavelength alone Many workers believe that no clear indication of such selective effect has been demonstrated and that results obtained apparently depend on

the amount of radiation absorbed Others maintain that where equal depth doses can be achieved by either agent the results from radium are superior It is however definitely established that with the harder quality of radiation from radium or from supervoltage X ray therapy of two million volts or more there is less likelihood of bone necrosis With X rays in the 200-250 kilovolt range there is an increased energy absorption in bone as compared with soft tissue but this ratio is reduced in the case of supervoltage radiation

(*b*) *Dose* —As far as quantity of radiation or size of dose is concerned there are further important considerations with regard to radio sensitivity For any individual tumour of moderate radiosensitivity there is a minimal dose which must be delivered before complete regression will occur If optimum dosage and technique are used there will be complete disappearance and the healed normal tissues will be soft and supple with a minimum of scarring The direct local effect of irradiation producing destruction of the most sensitive cells with damage to the remainder is completed by the indirect local effect of an intact and undamaged tumour bed In many cases if optimum dosage is exceeded but the dose still remains less than that which will produce unselective necrosis of tissue a condition may result in which the normal tissues will heal but with excess of scar tissue and much induration and residual neoplasm will still be present This alteration in radiosensitivity is probably due to excessive damage to the tumour bed inhibiting its essential activity in the process of growth destruction

(*c*) *Dose rate* —The radiosensitivity of tumours can be influenced by alterations in the rate at which the dose is delivered and by alterations in the overall time in which a course of treatment is given With radium by the insertion of needles or by a surface applicator it is possible to give continuous irradiation over a prolonged period of days With X rays extension of the overall period of treatment means that the dose must be divided into individual fractions These fractions may be given at varying intervals such as daily twice daily every second day or twice a week. Each fraction may be given quickly within a few minutes at high dosage rate or may be protracted over longer periods at a lower dosage rate Different tumours and different normal tissues have different rates of recovery and it is probable that there should be variations in this time intensity factor for the treatment of individual tumours Some are apparently best treated by a continuous irradiation others may need a considerable prolongation of overall time of treatment In many radiosensitive tumours the time intensity factor does not seem to be of great importance

Radiosensitivity of Malignant Tumours

Although all the factors which have previously been considered as affecting radiosensitivity must be taken into account in considering the radiosensitivity of any individual neoplasm and the type and

technique of treatment which should be used, it is possible to group malignant tumours according to the degree of inherent sensitivity which they possess Clinical experience has shown that three fairly well defined but overlapping groups can be formed which generally conform to (a) marked radiosensitivity (b) moderate radiosensitivity and (c) radioresistance Classifications of this nature have been published by Ralston Paterson A U Desjardins and Stanford Cade. They are all in close agreement and form a useful basis for discussion of the type of treatment which may be appropriate The following is the classification given by Cade —

(a) *Highly radiosensitive tumours*

Lymphosarcoma	Some parotid tumours
Lymphadenoma	Ewing s tumour of bone
Embryoma of kidney (Wilms s tumour)	Multiple myeloma
	Medulloblastoma
Seminoma	Lymphoepithelioma
Chorionepithelioma	

(b) *Moderately radiosensitive tumours*

Some lymphoepitheliomata	Some spheroidal cell carcinomata (breast)
Rodent ulcer (untreated)	
Transitional cell carcinoma	Some adenocarcinomata (breast thyroid)
Squamous cell carcinoma	

(c) *Radioresistant tumours*

Fibrosarcoma	Some parotid tumours
Osteogenic sarcoma	Teratoma
Adenocarcinoma of rectum	Some gliomata
Hypernephroma	Nævocarcinoma

In general terms the first group are not only highly radiosensitive but are also highly malignant and give rise to precocious and widespread metastases They are usually treated by radiotherapy as the main method of attack. Radiotherapy may be combined with surgical excision in some cases. Chemotherapy in the form of nitrogen mustard compounds and urethane is also used for the treatment of some of the tumours in this group They do not give rise to a high percentage of cures on account of their liability to metastasize.

The second group of moderately radiosensitive tumours are sometimes treated by radiotherapy sometimes by surgery and sometimes by some combination of surgery and radiotherapy They give rise to a much higher proportion of cures and among them are many of the more common superficially situated neoplasms such as those of the skin mouth and larynx cervix and breast

The third group are radioresistant and have generally proved refractory to treatment by the apparatus and techniques which have so far been devised They are generally problems for surgical excision. Radiotherapy is sometimes employed but usually as a pre or post operative treatment It is also used to a considerable extent as a palliative procedure in cases which are not amenable to surgery

CLINICAL REACTIONS OF THE PATIENT DURING AND AFTER TREATMENT

The clinical reactions of the patient undergoing radiotherapy for malignant disease may be conveniently divided into firstly those which are local to the region which is being irradiated and secondly those of a general or constitutional nature As in the majority of cases in which cure is attempted the degree of radiosensitivity is not very marked it is in most cases necessary to raise the dose level to the maximum that will be tolerated by the normal tissues This does not mean the maximum which can be given without the development of necrosis but the maximum which can be given without destroying the reactions of the tumour bed and after which the healed tissues will remain soft and pliable Dosage of this order provokes severe and painful reactions which may be difficult to tolerate by an aged and debilitated patient. Frequently the discomfort associated with a full course of radiotherapy may be more severe than that which would be associated with the surgical ablation of the same lesion It must not be thought that radiotherapy when cure is attempted is always an easy alternative to surgery as far as the patient is concerned

Radiotherapy may be used for palliation of symptoms such as pain or to heal an ulcerated surface in cases in which cure or appreciable prolongation of life cannot be hoped for In such cases high dosage should not be used and no severe reaction should be obtained It is not justifiable to produce a different and perhaps worse form of discomfort when palliation only is sought.

Skin

The first reaction which occurs on the skin is a transient erythema which may be so slight that it is not observed and which disappears within 24 to 48 hours of a single exposure. Following this there is an interval of from ten days to two weeks with no visible reaction and then the hairs in the irradiated area become loose and begin to fall out A gradually deepening erythema develops and depending on the size of the dose proceeds to a dry and then a moist desquamation The erythema and subsequent desquamation are strictly limited to the area which has been irradiated and can be seen to conform closely to the geometrical shape of the applicator which has been used to delimit the field of irradiation. There may be slight œdema of this area

In cases where moist desquamation develops the erythema becomes darker and blebs appear at first in places where there has been pressure from clothes or dressings or in skin folds. The blisters burst and the epidermis flakes off leaving a glistening moist pink surface with a considerable amount of exudation

If treatment has been stopped before or at the stage of commencing desquamation healing begins within a few days New epithelium

grows in from the edges of the irradiated area with considerable rapidity The growing edge of new epithelium which has a pearly appearance is irregular and is soon broken up into a series of prominences and depressions At the same time unless the dose has been a very heavy one small pearly circular islets appear irregularly over the centre of the raw area. They increase in size and by joining with the prominences of the growing edge cover over the whole field. This new epithelial covering is at first thin and tender but soon becomes thicker and harder Healing is usually complete in two to three weeks from the development of moist desquamation (Fig 566)



ig 566 – Moist desquamative reaction.

There is always some alteration of pigmentation which may be permanent or may fade after some months. Frequently the whole area is brown and darker than the surrounding skin but the pigmentation may be blotchy and uneven with areas which are lighter than normal skin

There is complete and permanent depilation following a moist desquamative reaction and the healed skin is dry from destruction of sweat and sebaceous glands There is also an alteration in texture, the skin having lost some elasticity through fibrosis of the dermis and there may be slight subcutaneous œdema lasting up to two or three months.

When large areas have been treated with heavy dosage there may be no formation of epithelial islets and the whole process of healing of the epidermis takes place from the periphery In such cases healing is delayed there is inevitably some scar tissue formation especially if the growing epithelium is traumatized by the frequent removal of dressings and the final result may be a thin adherent covering pigmented at the edges but pale in the centre.

Subsequent to healing of a moist desquamative reaction telangiectases may develop They are more frequent and severe after heavy dosage with consequent development of scar tissue Irradiated skin is always permanently less robust and more liable to damage than normal skin It must always be guarded from unnecessary trauma such as prolonged exposure to hot sunlight or extreme cold. During the stage of erythema which precedes desquamation the skin is itching and hot and during the stage of moist desquamation it is tender but usually there is little pain unless an area is involved which it is not possible to protect from chafing or constriction by clothes or dressings

The skin covering the flexures is particularly sensitive to irradiation and will tolerate smaller doses than other parts of the body the perineum in particular must be irradiated with caution

Mucous Membranes

The clinical reactions which follow irradiation of mucous surfaces are analogous to those which occur on the skin A typical example is the reaction seen in the mouth or pharynx during the treatment of an epithelioma. The first stage is a deepening erythema which commences somewhat earlier than the skin reaction at about the seventh to tenth day depending on the dose which has been given There is slight oedema of the mucosa of the area irradiated and the edges of the neoplastic ulcer become less raised and more rounded A fibrinous exudate then forms at first in discrete patches and then spreading to cover the whole area which is being treated It has a whitish yellow appearance is firmly adherent to the mucous membrane and if removed leaves a raw bleeding surface Its distribution and extent depends on the method of irradiation which is being used. If treatment is being carried out by the implantation of radium needles the fibrinous membrane is limited to the area included in the implant If treatment is being given from the outside by teleradium or by X rays it is inevitable that a greater volume of tissue and a greater area of mucous membrane will be involved and the fibrinous membrane may eventually extend over a considerable proportion of the mouth or pharynx

It gradually becomes thicker and masks the edges of the lesion which flattens out and becomes indistinguishable from the surrounding mucosa except for persistent but lessening induration After a week to ten days the fibrinous membrane diminishes in extent by healing from the edges and in a further seven to ten days may have healed completely

In cases with successful healing of a neoplastic ulcer the lesion heals under the fibrinous exudate and by the time it has cleared away the site of the ulcer may be distinguishable only by a slightly scarred and oedematous patch of mucosa.

Hypertrophic growths disappear with restitution of the normal outline of the organ involved but deeply ulcerated lesions where there has been destruction of musculature inevitably leave some deformity In the case of the tongue or floor of the mouth reduction of induration following treatment may allow a previously fixed tongue to become freely mobile again and it is not uncommon to find that a tongue which has been tethered and deflected on protrusion towards the side of the lesion becomes mobile and deflects towards the opposite side owing to destruction of musculature In some cases after heavy treatment mobility may again be reduced owing to the development of scar tissue

The local reactions to irradiation of the mouth may give rise to symptoms of pain and discomfort the severity of which depend on

the size of the area irradiated and the amount of mucous membrane involved With the development of the fibrinous membrane there is diminution of serous and salivary secretion which at first appears to be increased in volume because it becomes thicker and more tenacious and is more difficult to swallow There is also diminution in the sense of taste. The areas covered by fibrinous exudate are sensitive and painful and the more frequent acts of swallowing brought on by tenacious secretions may give rise to considerable pain If the faucial and pharyngeal regions have been widely involved there may be in addition pain referred to the ears from irritation of the glosso-pharyngeal nerve After healing there is usually some degree of dryness of the mucosa and loss of taste which may last for two or three months or even longer

Mucosal reactions in different parts of the body although essentially the same in nature raise many different problems and produce different symptoms according to the sites involved. The fibrinous reaction of the vaginal walls inseparable from the treatment by radium of carcinoma of the cervix may give rise to adhesive vaginitis with sometimes a slight persistent watery discharge The anterior wall of the rectum may be affected by the reaction with symptoms of tenesmus and frequent diarrhœa with flakes of mucus These symptoms if present are usually transient and pass off within a few days but in some cases especially if the growth has extended to the posterior fornix and heavy irradiation has had to be given to this area they may be more persistent and can be very distressing In severe cases ulceration and necrosis of the rectal wall has occurred.

The general or constitutional reactions to irradiation may be divided into (1) direct effects (2) indirect effects.

1 **Direct effects.**—(*a*) *Radiation sickness* is a clinical condition which is more likely to occur if large volumes of tissue are irradiated and especially if heavy irradiation is given to the thorax or upper abdomen Its true nature has not yet been determined, but it must be due to the absorption of some toxic decomposition products formed by the destruction of tissue by irradiation. The symptoms vary from headache loss of appetite and nausea to severe vomiting and extreme prostration It may be confused with or associated with similar symptoms of psychological origin which may occur in some highly nervous patients

(*b*) *Effects on the blood* —A prolonged course of irradiation to the thorax and abdomen as in the case of generalized Hodgkin s disease or in the treatment of the abdominal glandular areas after orchidectomy for a testicular tumour causes a marked reduction in leucocytes with a particular effect on lymphocytes Platelets are diminished and there is prolongation of coagulation time Slight anæmia may develop

2. **Indirect effects.**—The general condition of the patient may be severely affected as a result of the local reactions caused by irradiation. A severe fibrinous reaction of the pharynx occurring during the

treatment of a growth of the vallecula or of the pyriform fossa may cause impairment of general condition through dehydration owing to difficulty in swallowing and lack of appetite Pain and discomfort may cause lack of sleep These effects in a patient already in poor general condition owing to the symptoms caused by his malignant growth call for careful and skilled nursing Adequate sedation and local analgesics must be given and every effort made to ensure proper fluid intake.

Necrosis

The reactions which have been described above are those which are produced by design in attempts to cure various types of malignant disease and are the reactions which are produced when the dose given is close to the maximum which the normal tissues will tolerate If the dose has been excessive necrosis or widespread destruction of tissues may occur Radiation necrosis the X ray or radium burn may be early or late that is it may occur immediately following treatment or may not develop until months or years later in tissues which have appeared to be soundly healed.

(*a*) **Early necrosis.**—Early necrosis develops as an immediate sequel to a desquamative radiation reaction It may occur as the result of overdosage perhaps due to miscalculation of the factors involved in total dose overall time or volume of tissue irradiated or to some error in technique It may occur as the result of abnormal sensitivity of the tissues produced by extrinsic factors such as infection or poor blood supply as in cases of syphilitic glossitis the retreatment of previously irradiated tissues and the scar tissue of previous operation of burns or lupus It may occur in cases when a deliberate risk has been taken and the only possibility of cure appears to depend on the administration of heavy dosage

In cases where early necrosis occurs the erythema which may appear as early as the fifth day rapidly becomes a deep purple and the blisters which precede desquamation are large and confluent When the epidermis flakes off in thick sheets ulceration extends downwards and may involve the dermis only or the underlying muscles and bones A tenacious yellowish slough is formed which owing to local endarteritis and deficiency of blood supply may take weeks or months to separate If bone or cartilage is involved sequestration is particularly slow and may take months or even one or two years to be accomplished. The development of the ulceration is associated with severe and intractable pain which continues until the slough is separated and healing commences Localized necrosis due to localized irradiation where there has not been widespread damage to blood supply will heal slowly by the formation of scar tissue after separation of sloughs and the formation of weak granulations in the floor of the ulcer Measures which have been found useful are to attempt to liquefy and remove the slough by compresses or bathing with a

solution of bicarbonate of soda alternated with sodium hypochlorite and to diminish infection by the application of penicillin cream or 1 per cent aqueous solution of methylene blue More strenuous attempts to remove the slough may result in spreading of the area of necrosis

Where the necrotic lesion is extensive or where pain is very severe surgical excision of the whole area should be carried out with the removal of all damaged tissues until healthy freely bleeding structures are reached Diathermy coagulation is of value especially in cases of necrosis of the tongue or mouth If the coagulation is adequate in depth and carried out slowly with avoidance of charring it is followed by immediate cessation of pain and a healthy granulating surface results

When bone or cartilage is involved by direct extension of a neoplastic ulcer there is always the danger of early necrosis after heavy treatment In the treatment of carcinoma of the floor of the mouth or of the cheek with involvement of the mandible there is always some danger of necrosis with a prolonged period of invalidism. Sequestration may take months or years but no local surgical measures should be carried out until the margins of the necrotic area become defined, as early intervention will almost certainly cause a spreading necrosis throughout the whole mandible

Early necrosis of laryngeal cartilages will cause besides pain oedema with obstruction of the glottis necessitating immediate tracheotomy Necrosis of the rectal wall in the treatment of carcinoma of the cervix may need colostomy

(*b*) **Late necrosis.**—Late necrosis has been described as occurring as long as eight to ten years after the successful treatment of a neoplasm and after the tissues have appeared to be soundly healed. It may occur in an area which is scarred and obviously avascular or when the tissues appear perfectly healthy and the treatment has been correct and successful It may be due to some physical trauma or to the effects of infection on tissues in which there has been progressive impairment of blood supply by endarteritis. Sunburn or frostbite a heavy blow or some intercurrent infection may be the precipitating factor Heavily irradiated bone or cartilage in particular is incapable of producing an adequate inflammatory response and necrosis is likely to result A typical example of late necrosis is the following case In a patient who had been treated by radium needle implantation for epithelioma of the left side of the lower lip the lesion remained healed with an excellent cosmetic result three years later Following a cold he developed a herpetic ulcer partly on irradiated and partly on unirradiated tissues The unirradiated area healed rapidly but the irradiated tissues broke down in necrosis and healed slowly over several months with considerable deformity

The clinical appearance of late necrosis is similar to that of early necrosis It spreads rapidly to involve the whole volume of devitalized

tissue and when fully developed there is the same adherent slough the same slowness in sequestration the same intense pain (Fig 567)

The treatment of late necrosis involves the same principles as those of early necrosis Slow healing will occur in localized lesions in more extensive ones diathermy coagulation may be of value and excision may be necessary when the lesion has developed to its fullest extent Removal of sequestra must not be attempted until separation is complete for fear of spreading the necrosis Late necrosis may be difficult or impossible to differentiate clinically from recurrence of malignant disease. There are many disastrous cases on record where further radiotherapy has been given to an area of necrosis in the belief that neoplasm had recurred Late necrosis of the rectal wall in particular has been mistaken for recurrence of carcinoma of the cervix.



Fig 567 —Necrosis of the chest wall following deep X rays and radium needle implant for recurrent carcinoma of the breast.
Telangiectasis above necrotic area.

Necrosis is usually more painful than recurrent growth but the latter may sometimes also be painful and it must not be forgotten that necrosis and recurrence may both be present at the same time Histological examination of biopsy material is the only way to establish the diagnosis in many cases A negative result from biopsy does not mean that neoplasm may not be present. It may be that the specimen has been taken from the wrong area or has been too superficial When a negative report from biopsy is obtained in these cases a further biopsy should be taken and the final assessment of the presence or absence of recurrence may need three or four such examinations Late necrosis of bone may take place without any ulceration of the overlying soft tissues It has been observed in the neck of the femur when high dosage X ray treatment with large fields had been given to the pelvis It has also been described as having occurred in several ribs after irradiation of the chest wall following radical mastectomy at the line of junction of medial and lateral tangential fields The condition is of importance as it may be mistaken for bony metastasis of malignant disease and further irradiation carried out The first symptom may be a pathological fracture perhaps with only slight pain and this occurring in a patient who has previously been treated for cancer is likely to be interpreted as due to a secondary deposit The differential diagnosis by radiology may present some difficulty

Scar tissue caused by excessive radiation reactions or by the healing

of necrosis is liable like scars such as those from burns or from lupus to undergo epitheliomatous change after a lapse of many years and to present no particular distinguishing features

There is however a particular type of post radiation skin degeneration which frequently indeed almost inevitably if sufficient time elapses leads to epithelioma. Multiple small doses of irradiation each insufficient to produce even an erythema have a cumulative effect on the skin and if too frequently repeated will cause the changes of chronic radiation dermatitis. It has been seen particularly on the hands and faces of the majority of the pioneer radiologists who unaware of the biological effects of radiation exposed themselves in the screening of patients for diagnostic purposes and handled radium and X ray tubes for therapy with few or no precautions It has been seen also in patients who have been treated over prolonged periods by small doses of X rays for conditions such as psoriasis sycosis barbæ and thyrotoxicosis The majority of these radiologists and many patients have died as the result of the skin cancers which have been produced. The changes of chronic radiation dermatitis begin with a drying of the skin which becomes atrophic and inelastic There is diminution of subcutaneous fat and the skin appears to be drawn tightly over the deeper tissues. In some parts fissures appear which do not heal in others small warts come up and flake off only to appear again and grow larger When the hands are affected the nails become brittle and striated with cracks around the nail bed Eventually one or several of the fissures develop into epithelioma or the base of a wart becomes indurated and the starting place of a similar lesion

The development of irradiation induced cancer may take from ten to twenty years or even longer from the period of exposure. The lesions are typically multiple and when epitheliomatous degeneration has occurred they may suddenly undergo rapid evolution with early invasion of regional lymph nodes

Irradiation dermatitis should be treated by surgical removal of the involved skin and its replacement by grafting skin from other areas When the condition has proceeded to epithelioma formation wide excision with skin replacement should be carried out Amputation of one or more fingers or of the whole hand may be necessary if satisfactory and sufficiently wide local excision cannot be performed.

Irradiation induced epithelioma will respond and can be cured by further radiotherapy but this will cause still more damage to the tissues with the likelihood of necrosis or the development of other cancers at a later date.

In some few cases treatment of irradiation cancer by radiotherapy is justified When an epithelioma has developed on the thumb and treatment by surgery would mean amputation it may be possible to heal the lesion and save a useful thumb and hand at any rate for some years An example of this was a radon worker who had severe damage to his hands Three fingers on one hand were amputated in

the course of three years for epithelioma formation When a further lesion developed on his thumb it was treated by surface application of radium This treatment was repeated for subsequent early cancers and he was able to retain a useful hand for 15 years until he died from cancer of the stomach If there is any suspicion of metastatic involvement of regional glands block dissection should be carried out immediately

CARE OF THE PATIENT UNDERGOING RADIOTHERAPY

Before a course of radiotherapy for malignant disease is undertaken some preparation of the patient may be necessary Anæmia should be corrected if necessary by blood transfusion Any obvious focus of infection should be cleared up and in the case of lesions in the mouth pharynx or larynx special attention must be paid to dental hygiene. Some authorities advise the removal of all teeth whatever their condition because following heavy irradiation even good teeth are likely to become carious and gingival infection with recession of the gums develops The subsequent removal of teeth carries the risk of late necrosis of the jaw Short of complete clearance of the mouth it is necessary to remove all carious and infected teeth and to pay particular attention to cleaning and scaling the remainder If complete clearance is to be undertaken this must be done with caution removing only a few teeth at a time Wholesale extraction will not be tolerated by an aged patient who is already considerably debilitated by the presence of a growth with associated pain loss of sleep and inadequate diet.

Attention must also be paid to the alleviation of these symptoms Sedatives to relieve pain and promote sleep must not be withheld and adequate fluid and calorie intake must be assured If necessary nasal drip feeding should be used or fluids given by the rectum All irritating dressings or applications such as iodine or mercurial preparations which may increase reactions must be stopped and removed from any skin area that is to be treated

In all cases particular attention should be paid to encouragement of the patient and explanation of the nature of the treatment which is to be given It is necessary to have the patient s complete co-operation to carry through a radium needle implantation of the tongue lasting seven or eight days or an intra buccal radium mould the success of which depends on accuracy of position Many patients need reassurance and explanation before being installed and left alone in a teleradium or X ray treatment cubicle

During the course of treatment any skin area which is being irradiated needs special attention Before the stage of desquamation after gentle washing and drying it may be treated twice daily with spirit and starch powder to harden it in the same way as a patient s back is treated When desquamation has occurred it is best to keep the area as dry as possible if it can be left exposed and will not be

chafed by covering with clothes One per cent aqueous solution of gentian violet used as a paint is a useful dressing When the region has to be covered the desquamated area should be washed over gently with bicarbonate of soda solution one dram to a pint to remove excess of secretion and some bland preparation such as calamine cream or penicillin or sulphonamide cream should be applied. Every clinic has its own particular method of treating skin reactions It is of the greatest importance that the growing epithelium should not be injured by the frequent removal of dressings which stick to the surface and that the area should be kept free from infection. When the reaction has healed the patient must be warned that the area irradiated is more likely to sustain damage than normal unirradiated tissue. Exposure to hot sun or cold winds must be avoided. The area must be protected from friction and not damaged by hot water bottles or the application of any irritant ointments.

Mucous membrane reactions in the mouth and pharynx need skilled and frequent nursing care The mouth should be irrigated frequently with bicarbonate of soda solution which liquefies and cleans away tenacious secretions This should be done gently by some form of pressure irrigation using a dental syringe or atomizer Ordinary mouth washes are of little use and the treatment should not be left to be carried out by the patient

Extensive reactions may be painful and constant attempts to swallow sticky mucus may be distressing Various local analgesics have been tried with varying success in individual patients Some mixture with an aspirin basis has been found to be of greatest value as it has a local analgesic as well as a general effect. Adequate sedatives must be given to promote sleep and a high intake of fluids must be ensured The fluid intake should be charted and a minimum of five pints in 24 hours should be the aim

For radiation sickness the main requisite is skilled nursing Adequate fluid intake must be maintained and rest and sleep ensured. Sympathetic encouragement and some insight into the problems which arise in the course of a prolonged treatment are essential in the nursing care of these patients Various specific remedies have been advocated for radiation sickness. Liver preparations by mouth or by injection various members of the Vitamin B group and Vitamin C have had their protagonists Pyridoxin in doses of 100 mg daily seems to be of considerable value in many but not in all cases and Largactil is now being used with some success.

ACCURACY OF DOSAGE AND ACCURACY OF DISTRIBUTION

In order to obtain the maximum success from radiotherapy and to avoid accidents and the dangers of overdosage it is essential to know the dose distribution of radiation in each individual case. We must know the dose which is being delivered to the tumour and whether this dose is homogeneous throughout the whole volume of tissue which

includes the tumour and its possible microscopical extensions It is necessary to know also the dose which is delivered to the skin and subcutaneous tissue and to all the various tissues and organs which come within the field of irradiation

To obtain this knowledge it is necessary to have complete charts of the dose distribution from each piece of apparatus and the different working conditions which are used For the telecurie apparatus there must be charts of dose distribution for each size and shape of applicator and similarly for all X ray apparatus it must be possible to chart the dose distribution for any variation of applicator size or shape for alterations in quality of beam or of focal skin distance

The treatment of each patient who is going to receive high dosage should be planned individually When the full diagnosis including the size and shape of the volume of tissue to be irradiated has been determined a plan is drawn On this can be plotted the optimum arrangement of fields and optimum selection of beams of radiation to deliver a selected dose without overdosing the skin or endangering other sensitive organs

In the case of radium needle implantations the same care in preparation is essential. Simple rules for distribution of radium needles to produce practical homogeneity have been supplied by the work of Paterson and Parker and it is necessary to plan how they can be applied to each individual case When the plan has been completed its application must be carried out correctly it may be as a single plane a multiple plane or a volume implant The indiscriminate insertion of radium needles is unlikely to produce satisfactory results

With external irradiation by X rays or by teleradium it is not always a simple matter to ensure that a beam of rays of limited diameter will be directed accurately through a point situated at some distance below the surface of the body It is necessary to have various devices to ensure accuracy of beam direction It may be a plaster cast fitting accurately to the body surface with guides made to ensure accuracy of direction of the applicator It may be a device to mark out the centre of the emergent beam on the opposite side of the body By whatever means it is accomplished the various beams must be accurately directed.

After any radium needle or radon seed implant it is advisable to have a radiological examination with two views at right angles and preferably also stereoscopic views to observe the position of the needles and to calculate the actual dose being delivered It may be necessary according to the calculations made to alter the time at which the needles are to be removed to remove one or two needles earlier than the rest or in extreme cases to remove the whole implant and carry it out afresh

For these and many other of the calculations that are necessary for the proper planning and carrying out of treatment both by X rays and radium the help of a physicist specially trained in clinical radiotherapeutic work is essential

In radiotherapy physical accuracy in dosage and a complete knowledge of dose distribution is obviously essential and without it there can be no great measure of success except in particularly radiosensitive conditions It is however only one of the main foundations on which radiotherapy of malignant disease is based *The application of known facts of radiobiology in the development* of methods of irradiation and further additions to our imperfect knowledge in this field are essential to future progress. Both physical accuracy and knowledge of radiobiology are of real value only when they are added to a sound appreciation of the clinical features and clinical behaviour of various forms of malignant disease and their effect on individual patients.

INDICATIONS FOR RADIOTHERAPY

Radiotherapy may be used in some cases as (*a*) the sole method of treatment as for instance in lymphosarcoma involving the mediastinum lympho-epithelioma of the nasopharynx rodent ulcer of the face or carcinoma of the cervix uteri. It may be used alone because he results obtained appear to be equal or superior to those of other ı ethods or because the clinical stage of the disease is too advanced ıor surgical measures to be used. It may be used in association with surgery as (*b*) a pre-operative or (*c*) a post-operative treatment. In the treatment of carcinoma of the breast X ray therapy is extensively used in cases with axillary metastases as either pre- or post-operative treatment Its object is to extend the scope of the surgical operation to reduce the size and viability of the tumour prior to operation and to destroy any tumour cells which may remain following operation In some cases X ray or radium therapy may (*d*) be combined with a surgical operation For example a radium needle implantation may be carried out in the depths of the wound following removal of a mixed parotid tumour (*e*) Surgical exposure of a tumour may be necessary before certain techniques of radiotherapy can be used. The interior of the bladder must be exposed to allow the adequate implantation of radon seeds or radium needles A window of thyroid cartilage may be excised to allow radium needles to be placed in proximity to a carcinoma of the vocal cord. (*f*) Radiotherapy may be used for the primary lesion and surgery for metastases. Teleradium or radium needle implantation may be used for the treatment of the primary lesion in carcinoma of the tongue the glandular metastases in the neck being treated by block dissection. (*g*) Radiotherapy may sometimes be used as a diagnostic test It may not be possible to determine the nature of a mediastinal mass without performing a thoracotomy The rapid response of various forms of reticulosis to radiotherapy may be used to differentiate this type of tumour from a benign lesion and the necessity for exploratory thoracotomy may be obviated. (*h*) In some cases of recurrence after surgical excision radiotherapy may be the only treatment which is of value. Skin

nodules appearing on the chest wall or metastases in the supra clavicular region after mastectomy may be controlled permanently or for many years

It is essential to differentiate between treatment by irradiation which is designed as a radical procedure in the hope of effecting cure or at least marked prolongation of life and treatment which is carried out as a purely palliative procedure In the former case high dosage is frequently used marked reactions are caused with moist desquama tion fibrinous mucosal exudate and perhaps considerable discomfort and pain It is justifiable to produce such reactions and even in some cases to run the risk of necrosis if there is a reasonable chance of cure These are comparable risks to those of operative mortality and prolonged convalescence which must often be taken for the surgical cure of malignant disease

In treatments which are purely palliative it is not justifiable to proceed to such heavy dosage and to produce painful reactions which may cause as much discomfort as the symptoms which the treatment is designed to relieve

There is no place in the course of this general review for discussion of the details of radiotherapy of all types of malignant disease Some examples taken from each of the three groups previously described —(a) highly radiosensitive tumours (b) moderately radiosensitive tumours (c) radioresistant tumours—will serve as illustrations

HIGHLY RADIOSENSITIVE TUMOURS

The tumours which have been included in this group do not occur with great frequency The immediate response to irradiation may be dramatic and voluminous tumours may disappear with rapidity X ray therapy is the method usually employed owing to its suitability for the treatment of large volumes of tissue Unfortunately early and widespread metastases are the rule rather than the exception. Further radiotherapy may be used with success on individual metastases but the disease usually progresses to an early and fatal ending

Seminoma of the testis is an exception to this generalization. It is highly radiosensitive it metastasizes early but the addition of X ray therapy to simple unilateral orchidectomy has raised the five year recurrence-free rate from the neighbourhood of 20 per cent by surgery alone to more than 50 per cent The earliest metastatic spread is usually by way of lymphatics and involves the para aortic glands and particularly those at the junction of the spermatic veins with the left renal vein and inferior vena cava respectively Spread to inguinal glands does not usually occur unless the coverings of the testis are involved by direct extension Further glandular spread occurs in the mediastinum and supraclavicular region It is not uncommon to find a man with large fixed glands in the hypochondrium by the time that his attention has been drawn to the testicular swelling In fact several patients have been referred to the Middlesex Hospital for

radiotherapy who had been subjected to laparotomy on account of an abdominal mass and in whom the primary testicular lesion was only found at a later date Blood borne metastases with multiple deposits in the lungs may occur Their occurrence may be early but more frequently at a later stage

Simple orchidectomy with removal of the cord up to the internal inguinal ring is usually carried out an operation which does not delay the institution of X ray therapy to the regions of glandular spread. It obviates the necessity for heavy irradiation of the scrotum with the likelihood of sterilization of the opposite testis and provides the opportunity for histological confirmation of the diagnosis X ray therapy is begun almost immediately after operation If no glands are palpable on careful examination under anæsthesia the abdomen only is irradiated If abdominal glands are found to be affected the mediastinum is also irradiated.

It is necessary to irradiate the abdomen with large fields to be sure of including any possible glandular metastases and the dose which can be tolerated is therefore not a very high one. These patients frequently suffer from nausea and vomiting and there may be a marked leucopenia during the course of treatment The general reactions are such that it is difficult to complete a full course of treatment to the mediastinum and the abdomen but the degree of radiosensitivity of the tumours is so high that they *frequently disappear permanently with only moderate* dosage

In cases of lung metastasis if the patient s general condition remains good it is worth while to irradiate the whole thorax instead of the mediastinum Of 77 patients treated for seminoma of the testis between 1929 and 1946 at the Middlesex Hospital 52 that is 67 per cent were alive and free of recurrence at the end of five years

Ewing's tumour of bone, the pathology of which is still in considerable dispute responds rapidly to X ray therapy and individual lesions sclerose and disappear following moderate dosage. Unfortunately metastasis to the lungs other bones and to glands is likely to occur and the lasting cures are few in number (Fig 568)

In **Hodgkin's disease** patients can be restored to health and to economic activity over periods of years by repeated courses of X ray therapy In some cases there may be no further manifestation of the disease for five or ten years following an initial course of treatment. At the Middlesex Hospital from a total of 150 cases with histological confirmation of the diagnosis treated between 1937 and 1947 there were 58 i e 36 per cent surviving at the end of five years

MODERATELY RADIOSENSITIVE TUMOURS

This group includes the great majority of accessible malignant neoplasms although less radiosensitive than the former group they are also in general, less malignant and it is from this group that

radiotherapy produces its greatest percentage of successes In this group also surgical ablation may be successful in a high proportion of early cases and it is here that the choice between radiotherapy and surgery or some combination of both methods is most difficult to make



Fig 568 —Ewing's tumour of femur A, before and B after X ray therapy

In the treatment of **rodent ulcer,** both radiotherapy and surgery have a part to play There are some cases in which radiotherapy is strongly indicated and others in which surgical excision is the only form of treatment which can hope to cure the disease. There is a large group which can be treated efficiently by either method and the choice may rightly be determined by the experience and facilities available

The untreated case of rodent ulcer is among the most radiosensitive of this intermediate group of moderately radiosensitive tumours. Many of them may even be classed in the highly radiosensitive group Among them there is some difference in radiosensitivity according to

the macroscopic type of the lesion the small hypertrophic tumour being very sensitive the cicatrizing and sclerosing type being considerably less sensitive and the ulcerating variety being intermediate in its response When situated in the most common sites for the development of these lesions namely the exposed areas of face forehead and neck the tissues of which have a rich blood supply and



A



B

Fig 569 —Rodent ulcer treated by X rays. A, before, and B, after treatment.

provided they do not extend deeply to involve bone or cartilage they can be destroyed permanently in over 90 per cent. of cases by various methods of radiotherapy with excellent cosmetic results (Fig 569)

It is necessary to include in the volume of tissue to be irradiated the whole of the macroscopic lesion and a generous margin of apparently normal tissue to include microscopic extensions which are always present. Misjudgment of the size of the area which must be irradiated is the most frequent cause of recurrence just as similar misjudgment

of the amount of tissue which must be removed is also the most frequent cause of recurrence after surgical excision

The dose must be adequate and must approximate to the maximum that the normal tissues will tolerate Irradiation must be planned as a single course of treatment either as a single dose or as a fractionated treatment which is completed within a total duration of time which will allow the individual fractions of the total dose to have a summative effect and produce the typical clinical reaction of moist desquamation Multiple small doses given at intervals of a few days or a week or more are worse than useless By causing slight regression of the lesion and promoting fibrosis they create the illusion that the ulcer is healing In fact they make the cells of the tumour more radio-resistant and fibrose the tumour bed so that it becomes increasingly liable to undergo necrosis and quite impossible to cure by subsequent well planned radiotherapy



Fig 570 —Rodent ulcer with gross destruction of bone treated by deep X rays Alive and free from recurrence nine years later

There is a choice of many methods of irradiation for the treatment of these lesions The implantation of radium needles or of radon seeds radium or radon moulded applicators using gamma radiation and X rays of various quality of beam all in suitable cases produce equivalent results Meticulous accuracy of technique is of course essential.

Radium needle or radon seed implantation may be suitable for any lesion except those in close proximity to bone or cartilage with little depth of soft tissue In applications from the surface a harder quality of ray will be chosen for infiltrating than for superficial lesions Treatment may be given over a short time even in a single dose lasting only a few minutes for superficial hypertrophic growths but would be fractionated and spread over at least several days for the treatment of more infiltrating ones Radium beta ray plates for the treatment of rodent ulcers are not generally used at the present time Their effective range is limited and in any but the most superficial lesions there is the danger of recurrence in the deeper tissues. Rodent ulcers which extend to involve bone or cartilage have the best chance of cure from wide surgical excision If this is refused or is impossible for some reason there is still a chance of cure though the chance is not a good one by the use of heavy irradiation. This should then be undertaken and the best method is probably teleradium There is considerable

danger of the production of necrosis but it does not invariably occur (Fig 670)

In cases of rodent ulcer or epithelioma of the free part of the pinna of the ear even though cartilage be involved adequate radiotherapy may heal the lesion with a minimum of deformity If it is not successful and necrosis ensues surgical removal can still be undertaken and is not made more difficult. When the growth is invading deeply towards the meatus wide surgical ablation is the only procedure likely to cure the disease.

Cases of rodent ulcer which recur after irradiation should be excised as they are likely to be resistant and the previously irradiated normal tissues will not withstand heavy dosage Rodent ulcers which arise on or near the eyelids create special problems as if radiotherapy is used, great care must be taken to avoid irradiation of the eye with the possible sequela of cataract formation An implantation technique with intense local dose but rapid fall off may be used or a protective lead shield may be inserted into the conjunctival sac after preliminary cocainization and treatment given by low voltage X rays. The irradiation of growths of the inner canthus must be planned so that the frequent and clinically unsuspected extension deeply along the medial wall f the orbit is included in the treated tissue. Irradiation in the neighbourhood of the lower punctum or over the naso-lacrimal duct may cause sclerosis with epiphora and the possibility of surgical excision with plastic repair should be considered in all such cases in preference to radiotherapy

The rodent ulcers which occur on the trunk a much less common situation are usually somewhat less radiosensitive than the average lesion growing on the face They may be multiple and single lesions may have developed to a relatively large surface area when first diagnosed They are usually of a superficial type spreading with an irregular edge which has only slight induration. Behind the spreading edge the surface is usually covered with thin atrophic sometimes pigmented scar tissue If an adequate margin of apparently healthy tissue is included and the treatment by radium or X rays extended over some days these lesions can be healed permanently by radiotherapy In many cases however there is ample tissue available for excision and suture and this may be the easiest and quickest method leaving the least scar tissue and therefore the method of choice

Rodent ulcers which have recurred after surgical excision tend to be less radiosensitive owing to the presence of scar tissue and interference with blood supply All such cases need careful protracted treatment A particularly difficult problem is the patient who after excision of a rodent ulcer has had an early repair of the excised area by means of a pedicle graft If recurrence occurs at the edge of the excision it may spread rapidly and widely in the tissues of the graft and may not be diagnosed until it has become extensive and has involved bone These cases usually do not respond well.

Cancer of the tongue—In carcinoma of the anterior two-thirds of the tongue the primary lesion is usually treated by the implantation of radium needles Surgical excision should be used for (a) those cases which have spread to involve the mandible and which are therefore likely to be radioresistant and to give rise to necrosis (b) hypertrophic lesions of the tip of the tongue which are difficult to irradiate homogeneously (c) some cases with a pre-existing syphilitic glossitis in which the tongue is avascular and fibrotic and likely to become oedematous as the result of irradiation (d) some bulky lesions which involve the whole of the anterior two-thirds of the tongue and by their size make the result of radiotherapy problematical and (e) recurrences after previous radium treatment

Glandular metastases if operable should be treated by block dissection No form of radiotherapy has produced results comparable with those of block dissection when the glands remain mobile and limited in extent. If the glands are more extensive and if it is not possible to remove the whole mass of tissue by block dissection then it is preferable to treat by irradiation alone and considerable palliation can frequently be produced. Teleradium or the implantation of needles or seeds to localized glandular masses may reduce them to a symptomless thickening which may remain quiescent for periods of several years.

The results obtained in cancer of the anterior two-thirds of the tongue at the Middlesex Hospital from 1931 to 1942 were 29 6 per cent. recurrence free at the end of five years from a total of 144 cases. The five year recurrence free rate was 44 2 per cent of those which had no glandular metastases when first seen.

Maxillary antrum and ethmoids—In carcinoma of the maxillary antrum and ethmoids various combinations of surgery and radiotherapy have been used. At the Middlesex Hospital external irradiation by X rays or teleradium is used in the first instance after adequate drainage has been secured and the diagnosis proved by histological examination. The dose is carried to maximum tolerance of the normal tissues and when the reaction has subsided the alveolus and palate on the affected side are removed using an intra buccal approach The medial wall of antrum and lateral wall of nose are removed creating a cavity which is funnel shaped and widest at the bottom At this stage following the external irradiation there may be no growth remaining and the defect in the palate can be closed by an obturator which can be made as a denture. The cavity serves as an inspection opening for the detection of any early recurrence and there is no disability with regard to speech or swallowing If there is growth still present as shown by histological examination of the tissue removed at operation a further irradiation can be carried out by means of a moulded radium applicator fitting into the cavity The use of this technique from 1930 to 1941 has resulted in five year freedom from recurrence in 22 5 per cent of cases 22 being alive and well out of 98 treated.

Larynx.—Opinion has been divided on the relative places of surgery and radiotherapy in cancer of the larynx. In early cases of limited extent with the cancer confined to the anterior part of one vocal cord laryngo-fissure and excision the local application of radium needles by the Finzi Harmer technique after a window of thyroid cartilage has been removed and external irradiation by either teleradium or X rays have all given curative results which are approximately equal and of the order of 65 to 70 per cent recurrence free at the end of five years. The quality of voice after external irradiation may be quite unimpaired. It is better than that obtained by the Finzi Harmer technique which is better than that following laryngo-fissure and excision

Cancers of greater extent involving the whole or the greater part of one or both cords but which retain some mobility and have not extended to involve laryngeal cartilages are unsuitable for the Finzi Harmer technique and if treated by surgery will probably need total laryngectomy These appear to be most suitable for treatment by teleradium or by X-rays.

Advanced growths with fixation œdema and involvement of laryngeal cartilages and those with supra-glottic or sub-glottic spread do not respond well to radiotherapy The percentage of cures is small and there is a high incidence of post irradiational œdema and peri chondritis. Such cases are most suitable for total laryngectomy The following results have been obtained at the Middlesex Hospital by radiotherapy —

Intrinsic Carcinoma of the Larynx
1930–1944

Cases Treated Total	*5 Year Recurrence Free*
74	25 = 33 8 per cent.
Lesions of one or both cords and of anterior commissure	
45	20 = 44 per cent

Breast.—The place of radiotherapy in cancer of the breast is still a debatable one No method of radiotherapy alone has produced curative results comparable to those from radical surgery which remains the sheet anchor of treatment in early cases. In cases which are more advanced as shown by the development of axillary node involvement X ray therapy either as a pre- or post-operative measure is being used in many clinics in the hope of improving the results of surgery alone Conclusive statistical evidence as to its value has been

difficult to obtain because of the long life history of carcinoma of the breast and the difficulty of collecting adequate numbers of comparable cases There does now appear however to be adequate evidence that results are improved by both pre- and post-operative irradiation Post operative irradiation following radical surgery is difficult to apply to



A



B

Fig 571 —A, carcinoma of breast with extensive ulceration of skin treated by X rays. B condition healed nine months later No sign of recurrence after two years.

the chest wall in adequate dosage because of the devitalization of the tissues and danger of necrosis Pre-operative irradiation can be given with adequate dosage to reduce the tumour considerably in size and in a proportion of cases to destroy it so that there is no tumour tissue recognizable at the subsequent operation Its main disadvantage is that operation is delayed until the reaction from irradiation has

In osteogenic sarcoma, which is particularly radioresistant preoperative irradiation is also being tried to an increasing extent before amputation in an attempt to improve the gloomy results Radiotherapy is also used as an alternative to surgery where amputation is technically impossible or would give no chance of cure The lesion is reduced in size pain is relieved and increased calcification can be noted on subsequent radiographic examination The lasting successes are however few in number as the majority succumb from blood borne metastases

PALLIATION

The palliative value of radiotherapy in malignant disease should not be underestimated Treatment by X rays or by radium can be used to heal a foul ulceration and prevent hæmorrhage as may occur in advanced carcinoma of the breast. The patient who has been a misery to herself and to her family may be able to return home without dressings and to live a comfortable life at least for some months

Treatment may be given to reduce a tumour mass causing pain from pressure on nerves or to relieve the dyspnœa and œdema caused by a mediastinal swelling The pain of skeletal metastases from carcinoma of the breast may be excruciating and difficult to relieve by drugs. Following X ray therapy such metastases usually become painless osteolytic deposits consolidate and pathological fractures may be induced to heal

Bronchus —Radiotherapy of carcinoma of the bronchus is in the majority of instances a palliative procedure. The incidence of this form of cancer is continually increasing Up to the present time surgical removal is the method of treatment which gives the best chance of permanent cure but unfortunately the great majority of cases are inoperable when first seen Many have severe symptoms of hæmoptysis dyspnœa pain or anorexia and these can frequently be alleviated or abolished by X ray therapy The numbers of permanent cures are very small and very little prolongation of life is obtained in the remainder but the palliative effect in chosen cases is of real value

The irradiation of pulmonary metastases occurring in some tumours of marked radiosensitivity such as seminoma chorionepithelioma or anaplastic carcinoma of the thyroid may be followed by complete and lasting regression. Such treatment should be undertaken whenever the patient s general condition allows In the majority of cases of pulmonary metastases e g those from the breast or kidney radiotherapy will cause no improvement and will probably increase the rate of deterioration of the patient

Œsophagus —Cancer of the œsophagus has proved disappointing in terms of curative results from all forms of radiotherapy This form of squamous cell carcinoma has a moderate degree of radiosensitivity It is however difficult to deliver an adequate homogeneous dose to the whole of the tumour and to avoid excessive irradiation of lungs and

mediastinal tissues In addition the healing powers of the œsophageal wall are poor Radiotherapy either by beam directed limited fields of X rays by rotational X ray therapy or by intra œsophageal radium applicators produces palliation with restoration of ability to swallow



A B

Fig 572.—A, carcinoma of œsophagus treated by X rays to tumour dose of 5 000 r in nine weeks. B condition four months after commencement of treatment. Normal swallowing regained.

in the majority of cases Such improvement however is usually not lasting and long term freedom from recurrence is rare (Fig 572)

Radiotherapy should not be withheld when any benefit can be obtained even if this be only temporary Such benefit may not be measured by statistics but it is none the less real

There may however be a tendency to refer patients for radiotherapy when no real palliation can be given and when treatment would be merely in the nature of a placebo There are other cheaper and simpler methods of giving psychological help to the advanced cancer case and radiotherapy should not be used in this way Only too often

does the patient believe that the sometimes inevitable distressing terminal symptoms are due to the radiotherapy and not to the disease thus bringing radiotherapy into disrepute.

Surgery and radiotherapy have been until recently the only effective weapons in the treatment of malignant tumours The long held concept of malignant growth as autonomous limitless and independent of the economy of the organism on which it thrives is beginning to be shaken The outstanding example of this is the discovery that frequently carcinoma of the prostate is dependent on an adequate level of androgens in the blood there is also the striking effect of castration of the administration of oestrogens or androgens and more recently of adrenalectomy on some carcinomas of the breast In a different sphere nitrogen mustard urethane and other cytotoxic poisons are the first gropings towards a rational chemotherapy of malignant tumours

It is essential that all these methods of treating cancer should be considered as complementary to one another and not in any way antagonistic or mutually exclusive The choice of one or the other or of some combination of methods of treatment should be made according to our present knowledge of which method is going to produce greatest benefit to the patient and not because of the ready availability of one method depending on the experience of the practitioner who is consulted

This should mean that if best results are to be attained there should be close collaboration and frequent consultation between the clinicians experienced in all these various forms of treatment

CHAPTER XXVI

OPERATIONS ON THE SKULL AND BRAIN

By SIR GEOFFREY JEFFERSON, C B E

INTRODUCTION

THE tumours which arise from structures within the cranium are varied in their histology and life history They comprise some 15 varieties ranging from completely benign neoplasms (such as the pituitary adenomas the acoustic neuromas most of the meningiomas and some of the gliomas—especially the cerebellar hæmangioblastomas and astrocytomas) to others so malignant that they are not worth operating upon (e.g the glioblastoma multiforme) Even these last are only locally malignant gliomas can only metastasize if they have access to the cerebro-spinal fluid and meningiomas only if they invade the dural sinuses As a surgical generalization it is no great matter whether a tumour which does not seed itself elsewhere is essentially benign or malignant so long as it can be removed with a reasonable margin of healthy tissue around it The brain presents the anomaly of relatively benign tumours causing death because they are inaccessible (e.g the meningiomas of the clivus) or because they arise in an area so physiologically important that they cannot be excised by block resection (e.g gliomas involving the motor and speech areas) It must ever be a matter of chance whether the tumour lies in such a position that it can be radically attacked. The malignant glioblastomas have a habit of infiltrating the temporal lobe the insula and basal ganglia and of cutting the motor and sensory projection fibres very rarely occupying the polar position that would give the best chance of radical extirpation Dealing with this type of tumour Dandy and others have removed the whole hemisphere hoping for radical cure but the basal ganglia have to be left behind so that recurrence is very possible. I have no doubt that the malignant glioblastomas should not be operated upon unless they occupy unusually favourable positions Still say what one will we all find ourselves operating upon these tumours some time or another generally because it has not been possible to discover the real nature of the tumour in advance. Nowadays it is often easy to say what kind it is by means of angiography (which shows up its vascular pattern) and thus to determine beforehand what if anything should be done The benign tumours are often harder to diagnose than the malignant because they do not destroy brain tissue to the same extent The intracranial lesions most worth while are the injuries abscesses meningiomas pituitary tumours acoustic neuromas most cerebellar tumours and the aneurysms and angiomas

PRINCIPLES OF NEURO-SURGERY

It is possible to define certain principles for the successful handling of intracranial tumours Amongst them are these that the lesion should be accurately localized both as to situation and extent that the approach should be so made as to expose it fully that its nature should be recognized *in situ* so that it may be dealt with appropriately The surgeon must be so fortified by physiological as well as anatomical knowledge that he does not inflict damage in excess of that natural to the lesion in other words he must know what is the maximum good that he can expect from each individual intervention He must see to it that every detail which can be used to build up a picture of the lesion and of its effects in all senses has been extracted beforehand and that no detail in preparation has been omitted that might lead to defeat Neuro-surgery demands an apprenticeship in which the neophyte learns to regard all lesions as exercises in applied physiology and all operations as experiments to be carried out with the greatest caution and solicitude for the welfare of the patient. For this reason an unhurried technique with the avoidance of blood loss the gentlest handling of tissues and the use of the least irritating of all ligature and suture materials (fine silk) is the ideal These principles are equally those of general surgery they cannot be forgotten without detriment

The doctrine of *primum non nocere* is an important one for surgeon and physician alike. It must be admitted that there are times when this adage is difficult to respect When for example an unexpectedly large and irremovable glioma has been exposed under high pressure and bleeds severely into itself a paresis previously no more than a ghost may change into a very patent hemiplegia. Or again the extraction of a benign tumour which is doing little damage to neural structures as it lies undisturbed may lead to a paresis or worse Fortunately this latter type of complication generally clears up in a short time Such happenings are distressing to everybody (not least to the patient) but are the inevitable result of the invasion of surgery into tissues highly charged with function.

In the pages which follow it has not been possible to give a full description of all operations or even of all which are reasonably common The surgery of access has been described in some detail, also that of a few of the more widely known conditions. Even so the description of the actual attack on the various tumours is wanting in detail for divergences from the typical are so common that a proper account would consist in each case of a number of detailed examples of actual instances It is hoped that those who wish to learn more may be stimulated to acquire that knowledge by a proper discipleship

DIAGNOSTIC PROCEDURES

Ventriculography

Although it is possible in the majority of cases to localize an intra cranial tumour from the history neurological signs and X ray

evidence there are many cases in which tumours fail to give those classical signs of localization which surgeons feel they have a right to expect The surgeon needs to be more exact than the physician in defining the precise situation of a tumour for his is the responsibility for the correct attack If the presence of a tumour is the only certain fact while its site is clinically debatable mechanical diagnostic means must be used Many data can be obtained by ventriculography (*a*) it may confirm the tentative diagnosis already made (*b*) it may upset the diagnosis and provide information leading to a more exact approach (*c*) it may bring to light unmistakable evidence of the nature of the lesion or (*d*) it may rightly deter the surgeon from operating at all by disclosing diffuse neoplastic spread e g in the basal ganglia The indications for ventriculography can therefore be stated in very wide terms it is a means for the exact definition of the situation relationships and extent of a space-occupying intra cranial lesion. It must be remembered that although the foregoing is perfectly correct the pendulum has swung recently and heavily in favour of angiography for the reason that it upsets the balance of intracranial pressure less and is therefore less dangerous The changeover can be illustrated by reference to figures from my own service for whereas in 1947 there were 75 pneumograms to 70 angiograms in 1950 there were 450 angiograms to 48 air studies and in 1954 604 to 24 air ventriculograms

Technique.—The operation on adults is invariably performed under local anæsthesia with the patient seated in the dental chair after the preliminary administration of sodium phenobarbitone gr 3 to 4 overnight and codeine phosphate gr ½ half an hour before the appointed hour In children general anæsthesia is necessary The head rest should be fitted against the mastoids rather than the back of the head It is the custom to burr two holes and to tap both ventricles Originally only one hole was made but the air may fail to pass from one ventricle to the other owing to air locks and then filling is uncertain and interpretation fallacious

Incision.—The burr holes are made posteriorly 7 cm above the inion and 3 cm to either side of the midline. (Fig 578) The original practice was to make them much lower but such punctures sometimes damaged the visual cortex and optic radiation with results sufficiently disturbing to force the puncture to the higher and safer level which lies between the visual and motor areas in the posterior part of the parietal association field. With the patient sitting up and with the head unencumbered with drapes two horizontal incisions are marked out with iodine at the site indicated. After local infiltra tion a horizontal incision 3 cm long is made between compression swabs down to the bone at the marked site A self retaining retractor is at once inserted and this as a rule completely stops bleeding If any vessel gives trouble it is picked up separately When the pericranium is pushed aside a portion of the lambdoid suture is

generally seen it is an excellent place for a drill hole because its digitations hold the point of the perforator and symmetrically placed holes are easy to make The bone is drilled and burred through in the direction which the cannula is to follow The fine scale of bone covering the dura which the burr leaves so neatly is next elevated. Both holes are made before ventricular puncture The dura is inspected and any vessel that requires coagulation having been

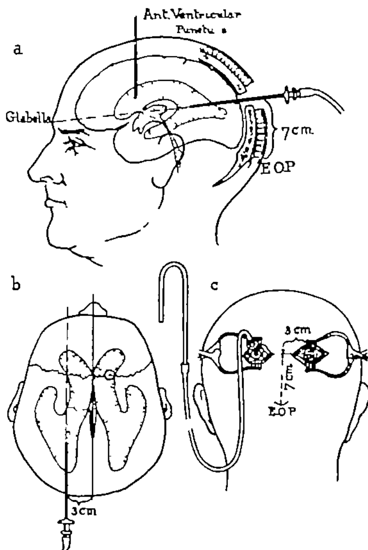


Fig 573.—Ventriculography Bilateral posterior puncture. Ventricular estimation with U tubes. Site of anterior puncture also indicated.

attended to a cruciate incision is made over the whole width of the opening Too small an opening grips the cannula so that its direction cannot be properly controlled and further makes it very difficult to tap the ventricle later in order to release the air Cortical vessels must be avoided or coagulated otherwise troublesome hæmorrhage may necessitate further bone removal to control it. The cannula is now introduced first on the supposedly normal side The

direction of its entrance is important (*see* Fig 578) It is directed straight forwards in a plane just above the top of the ear so that it points (*a*) roughly level with the glabella and (*b*) laterally in line with the pupil. The ventricle is encountered at varying depths according to its size. In cases of advanced hydrocephalus it may be met with only 3 cm from the dura ordinarily the distance is 5 to 6 cm It is usually possible to tell by touch when the cannula pierces the ependyma to enter the ventricle The stylet is momentarily removed to verify the fact that the cannula is in the ventricle and immediately replaced so that cerebro-spinal fluid is not lost The other ventricle is then sought in the same way

Ventricular estimation.—When both ventricles have been located the cannulæ are each connected with a piece of fine rubber tubing 80 cm long ending in a fine curved glass tube (Oljenick) The cerebro-spinal fluid pressure on each side can then be read off and noted it varies between 0 and 1 000 mm. according to circumstances Removal of fluid from one ventricle will be accompanied by a fall of pressure in the other if the interventricular foramina and the anterior end of the third ventricle are unobstructed. In making the punctures the surgeon has already obtained an excellent idea of the position of the ventricles while from watching the behaviour of the cerebro-spinal fluid in the tubes he can learn something of their size and their intercommunication The facts learned by ventricular estimation are significant rather than mathematically exact The height of the fluid column on each side depends not only on the pressure but also on the quantity of cerebro-spinal fluid present For example the pressure in a ventricle might be very high but the amount of fluid so inconsiderable that it did not fill the measuring system Pressures can only be compared when the amounts of fluid available are equal or nearly so Measurements whether registering inequalities in the fluid volume of the ventricles or not show the height of the intracranial pressure as nothing else can. Enlarged ventricles usually indicate a subtentorial lesion but they occur also with some supratentorial conditions (e g pineal tumours third ventricle cysts gliomas of the basal ganglia stenosis of the aqueduct) It is therefore not safe to draw a firm conclusion without injecting air (or Myodil)

Air injection.—This is done with a 10 c c. Record syringe fitted with a two-way tap and with a short length of rubber tubing between the cannula and the nozzle Cerebro-spinal fluid is extracted 10 c.c at a time and a slightly smaller quantity of air is injected, *pari passu* The procedure is repeated on the other side. The whole dental chair should be tilted far backwards during the replacement so as to ensure that the air runs well forwards and that all fluid is secured. It is better to leave the cannulæ open for a moment before withdrawing them even though air is lost If it has only been possible to introduce a very little air and that into only one ventricle the other should be punctured by a fresh burr hole anteriorly (*vide infra*) The ventricles normally each contain about 12 c c of cerebro-spinal fluid In the

average hemispheral tumour one ventricle is always larger than normal so that all told 25 to 35 c c. can be introduced. Good pictures can be obtained with this amount but useful information is given by less In hydrocephalic cases the fluid obtainable may range from 100 c.c upwards Even then it is rarely necessary to inject more than 75 to 80 c.c. all the information required can be obtained by moving the air about into the different parts of the ventricular system. Very large replacements (200 to 500 c.c.) easily made when a huge hydrocephalus is present are usually fatal even when continuous drainage is employed afterwards or the obstruction removed. If 100 c c or more have to be removed to get accurate enough pictures the cerebro-spinal fluid should be preserved and replaced after the X rays have been taken. After the necessary X ray films have been exposed the ventricle should be again punctured to allow the air to escape if this is not done the pressure when the dura is opened at operation will be excessive In making this puncture there may be difficulty in finding the burr hole for its centre does not always lie immediately under the closed incision. It is then necessary to remove the sutures and reinsert the cannula under direct vision. The ventricle of the side opposite to the tumour is that from which most air can be released Alternatively a piece of narrow polythene or silicone tubing can be pushed down an open-ended cannula which is then withdrawn. The tubing is tied off to prevent the air escaping until the X rays are completed when it is a simple matter to release the air and remove the tube It can be left for continuous drainage into a sterile bottle raised at least 15 cm above the patient s head should this seem advisable for clinical reasons

The foregoing account has been left intact because the beginner must know the anatomy of the ventricular system and its appearance in the living But in Manchester intra ventricular air is now being superseded by fractional Myodil ventriculography (see below) In 1954 air ventriculography was used 24 times Myodil 54 times There is no substitute for air or oxygen for cisternal or lumbar encephalography — used on 160 cases

Anterior ventricular puncture —A burr hole is made 2·0 cm. from the midline over the coronal suture (*see* Fig 578) and the cannula directed almost vertically downwards towards the base but inclined slightly medially though not so much so as to strike the falx When the ventricle has been entered the remaining steps of the air replacement are as already related The puncture is more efficiently done if the patient is removed from the dental chair placing him face downwards on the table for only in this position can sufficient fluid be extracted and the air retained in the posterior parts of the ventricles.

Fractional ventriculography with Myodil —This anterior puncture is ideal for fractional ventriculography with a radio-opaque substance such as Myodil. This is much less upsetting to the patient s intracranial physiology because with as little as 1 or 2 c.c. of Myodil

excellent information can be obtained about the state of the third ventricle and the width shape and angulation of the aqueduct The Myodil placed in one ventricle can by manipulation of the head be coaxed through the foramen of Monro into the third ventricle and then back into the aqueduct As a rule we are looking for evidence to decide whether a patient has a patent third ventricle or aqueduct or whether a cerebellar tumour is present If the lesion is in the posterior fossa, not only will the Myodil shadow show very clearly the kinking of the iter so characteristic of subtentorial lesions but the fourth ventricle may be outlined in such a way as to suggest the nature and situation of the tumour The Myodil escapes from the ventricular system quite easily unless there is a stricture of the iter or a blocked third ventricle but even then it rarely does any harm

Difficulties.—Theoretically it should never be impossible to find both ventricles nevertheless one may escape the search Often this does not matter because the air injected into the one may cross into the other during manipulation of the head. With third ventricle pineal and cerebellar tumours both ventricles are found easily in the same situation on either side and at the same depth. When the tumour is frontal the posterior horns and trigones are usually not displaced if one of them is out of position and the tumour is later shown to be well forward this is a bad sign prognostically for it points to a diffuse lesion or to widespread œdema When the tumour is more posterior in the hemisphere or temporal the ventricle is almost always out of place and must be sought nearer the midline The surgeon is always gratified when the ventricle is struck with the first puncture sometimes it will only be found after three or four attempts. More than this should not be made Each successive attempt must be deliberate after taking careful bearings on direction It is my practice to place only one thin folded wet towel 6 in wide across the vertex so that perfect orientation can be maintained throughout If necessary even this towel can be removed. Sometimes fluid begins to flow from the cannula at a great pace suggesting abundant reservoir and then suddenly stops This is characteristic of the small ventricle on the side of a tumour and it is generally useless to move the cannula about trying for more the cerebro-spinal fluid merely becomes stained with blood. If there is bleeding it is better to leave the cannula *in situ* and to keep it still. A little air can be introduced even if the ventricle is very small indeed and it is best then to withdraw the syringe and cannula together In the course of the punctures the tumour may be encountered as the needle enters A meningioma is recognized by its resistance a gliomatous cyst by the yellow fluid which escapes a glioma by an alteration in the resistance If a cyst is located it is a help to fill it with air or to inject about 2 c c of thorotrast into it (Dott) It is unwise to move the cannula about if it strikes a glioma for this may cause hæmorrhage.

The actual interpretation of ventriculograms is not always easy and close collaboration is necessary between the surgeon and the

radiologist Search must be made not only for alterations in the lateral ventricle contours but for filling defects and displacements of the third ventricle the iter and fourth ventricle

Complications.—The question of complications after ventriculography brings up the rule that it should be followed at once by the appropriate operation Only thus can fatalities be avoided, though it is true that if this plan is adopted, the mortality of ventriculography becomes submerged in that of the surgery of the tumour Occasionally operation may be deferred to another day especially if the patient is tired out by the proceedings in the X ray room The plain fact is that no one can foretell what will happen in each and every case ill patients sometimes survive a delay whilst those in better condition may unexpectedly succumb But in general the more ill the patient the less safely can he be left The most potentially dangerous subjects are those with temporal tumours those with violent intermittent headaches and those with severe pain in the neck for then a pressure cone is probably forced into the tentorial hiatus compressing the mid brain or a cerebellar cone into the foramen magnum Ventriculography is then hazardous and no such case can be left without operation at the earliest moment possible

Operation may be deferred with comparative safety in extremely well subjects with slight or absent pressure signs or where hydrocephalus is present The time before operation can be spent in decompressing the ventricles by drainage with the finest rubber tubing introduced through the puncture hole by a brain cannula. If carbolized dressings are used there is little risk of infection. Some patients have been so exhausted by the prolonged manœuvres in the X ray room (an hour or even two may elapse before the radiologist is satisfied) that it may appear relatively safer to defer the major operation. As a general principle I must reaffirm the rule of following ventriculography with an operation for the relief of the condition which has made the proceeding necessary and add that as a matter of experience this rule can occasionally safely be broken All these dangers are much reduced by fractional Myodil ventriculography

ENCEPHALOGRAPHY

The replacement of cerebro-spinal fluid by air through a needle instead of through burr holes is a simple surgical procedure. Air can be injected either (*a*) by cisternal or (*b*) by lumbar puncture. It is very useful when information is required concerning the ventricular and cortical patterns of epileptics or concerning the basal cisterns (as in arachnoiditis in gliomas of the optic chiasma pituitary adenomas and optic atrophy of uncertain ætiology) A lumbar puncture must be made on a previous occasion with the patient lying on the side the cerebro-spinal fluid pressure recorded on a manometer and all possible information extracted from the fluid cytology chemistry gold curve and Wassermann reaction before anything further is

undertaken Oxygen is better than air for encephalography especially by the lumbar route because considerably greater quantities of gas are required than are needed for ventriculography and oxygen is absorbed much more quickly than air

Technique. (*a*) The cisternal route —This procedure is preferable to lumbar encephalography because it upsets the patient less and the ventricles fill more easily A rise of intracranial pressure used to be regarded as an absolute contra indication to encephalography When encephalography was done by the lumbar route the fear was that tonsillar herniation might be present and the dangers of lumbar puncture then are well known The situation is different with cisternal (as distinct from lumbar) puncture. If a cone is present no fluid can be extracted from the cistern and no damage is done In some clinics cisternal encephalography is now preferred to ventriculography which is reserved for failed cistern punctures and for those with known posterior fossa lesions That considerable experience with cisternal puncture is necessary before pneumograms are regularly made by this route is self-evident especially if its use is extended to neoplastic cases But I have become convinced by experience that it is a safe practicable and advantageous method the dangers of which are in skilled hands more theoretical than real.

The operation is done with the patient sitting He may be seated astride a chair or placed sitting with the forehead in a head rest. The latter position requires of course a special operation chair The head should be slightly flexed special care must be taken to ensure that the head is in no wise rotated. A point half way between the external occipital protuberance and the spine of the axis is novocainized and a graduated lumbar puncture needle inserted in the direction of the glabella. (Fig 574) If the needle has been inclined too sharply upwards it will strike the skull base behind the foramen magnum the direction must then be corrected. If the aim is accurate the occipito-atlantal ligament is reached at a depth of about 5 cm (in very muscular men 6 cm) The engagement of the point of the needle is recognizable because it feels fixed previously it could be moved about This is the only sure guide to depth it may be reached at less than 5 cm After the ligament is reached a further advance of two or three millimetres carries the needle point into the cisterna magna A depth of 6 5 cm must not be exceeded. In a non neoplastic case the cerebro-spinal fluid pressure may be zero or less in the erect posture so that no fluid emerges it is therefore important that the correctness of the positioning of the needle tip should be verified by aspirating with a syringe This is important. When pressure is raised fluid drips out at once Ten c c. of fluid are extracted and 10 c c of air or oxygen then introduced. This is repeated until 30 c c have been injected sometimes considerably more can be introduced depending on the amount of fluid obtainable

I have never seen trouble follow cisternal puncture even when cerebellar tumours were present No fluid can then be obtained and

there is an end of it ventriculography must be performed. The failure to obtain fluid has meanwhile given an important clue.

(*b*) The lumbar route (patient sitting) —This is the safer method for the beginner though much more disturbing to the patient who almost invariably becomes shocked and sick at some stage of the replacement The reason why lumbar insufflation is so much more disturbing than cisternal is because the whole cerebro-spinal fluid

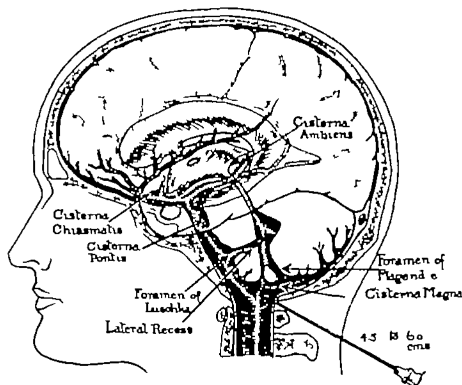


Fig 574.—Encephalography by cisternal puncture. Ventricles and chief cisterns shown.

column from the vertex to the level of puncture, is interfered with whilst the cisternal route leaves the spinal portion undisturbed. Although the patient may feel very ill and complain bitterly of headache no harm ensues nevertheless there is much to be said for the administration of an intravenous anæsthetic (evipan or pentothal sodium) for the operation. The difficulty then is to support the patient in the requisite sitting position with the head upright but this can in practice be readily achieved.

It is now an increasingly common practice for the radiologist to make encephalograms himself by withdrawing 5 c.c. of cerebro-spinal fluid at a time and injecting 5 c.c of air X ray films of the head antero-posterior and lateral, are taken after every 10 c.c have been injected up to a total amount of perhaps 40 or 50 c.c often less It is much more informative to watch the gradual build up of the pattern of the ventricles in this way stage by stage When the radiologist has the information sought for he can stop The method formerly used was

to inject anything up to 100 c c or even more of air and then take the pictures afterwards This method may still be used but its results are inferior

Difficulties and complications.—It is wise to move the patient s head about during the injection because in some persons the air goes over the cortex much more readily than into the ventricles and this may hold true even on repetition There is no universally applicable reason for this Good ventricular outlines may be secured with no more than 25 c.c. if all the air happens to go inside but in order to make certain of clear pictures of the meningeal spaces and ventricles larger rather than smaller quantities must be employed

The only sequelæ of encephalography are shock and very bad headaches worse if the gas is chiefly in the meninges and much less obtrusive after cisternal insufflation The discovery of an unsuspected tumour would be an indication for immediate operation The surgeon ought not to be taken unawares in this fashion if he has studied the case beforehand as fully as he should have done. Patients need a good deal of sympathetic attention and nursing comfort during the first hour or so after the radiographs have been taken.

Angiography

Egas Moniz of Lisbon introduced contrast radiography of the cerebral vessels in 1927 a method that has come to be called angiography Thorotrast (thorium dioxide) was the substance originally employed but Diodone or Pyelocil (35 per cent iodide solutions) are now employed in preference since they are rapidly absorbed from the cellular tissues of the neck. Some leakage always occurs

Indications.—(*a*) It is possible to prove the existence of abnormalities of the cerebral vascular tree such as aneurysms In regions other than the brain aneurysms are becoming great rarities The vast majority of those which arise from the carotid artery and its branches and on the circle of Willis are non-syphilitic and are due to congenital or arterio-sclerotic weaknesses of the arterial walls When they spring from the carotid trunk they demand surgical treatment the nature of which depends on the site and size of the lesion (*see* p 1491) The necessary facts concerning the aneurysm can be learned only by angiography (*b*) The second indication is for the demonstration of other vascular abnormalities—the angiomas of the brain They are usually of an arterial or arterio-venous kind and are a by no means uncommon cause of subarachnoid or intracerebral hæmorrhage in young adults or of epilepsy (*c*) The third indication of which great use has been made is for the localization of cerebral tumours In many respects the information given by angiography is superior to that given by ventriculography Owing to differences in the vascular supply of the meningiomas and gliomas and of subdivisions in the latter group again it is frequently possible to determine the nature of the tumour as well as its site As has been said angiography

has the advantage over ventriculography that it can be used in cases of high intracranial tension without fear of upsetting the blood and cerebro-spinal fluid balance and therefore need not be followed by immediate operation Two methods are in common use, closed and open.

Technique.—Percutaneous method now much the favourite consists in direct puncture of the carotid or of the vertebral artery by a sharp needle of No 17 bore The details of technique will not be described because success can only be attained by training with someone who is a master of the method The high proportion of successful punctures and injections is as gratifying as it is surprising Sometimes a good injection cannot be made and then recourse must be had to the older open procedure

Open method.—Under local anæsthesia the relevant carotid artery is dissected out in the neck and underrun with silk slings so that it can be drawn forwards. The patient is now placed on the X ray table Injections of 7 to 10 c.c. of Diodone are rapidly made under direct vision and X rays taken in the course of the injection. Several films are exposed during a period of 4 or 5 seconds starting from the time when the plunger is half way down the syringe barrel. It is necessary to have further syringes at hand ready filled with saline to prevent the needle becoming clogged until the radiologist is ready to take views from a fresh angle. This is very necessary during percutaneous angiography as well The carotid rarely bleeds to any important extent after puncture of its wall.

In the University Neuro-surgical Clinic in Manchester percutaneous angiography—by way of the carotid artery for hemispheral lesions by way of the vertebral for those in the posterior fossa or posterior cerebral distribution—has now overtaken and passed all other mechanical means of diagnosis (except the E E G) Bilateral angiograms are commonly made to give a complete picture of the cerebral vasculature and to reveal the vascular relationships of tumours or angiomas or aneurysms. The figures for the different sorts of procedure were given on an earlier page

GENERAL TECHNIQUE

Blood Loss

The care needed to minimize hæmorrhage during entrance is referred to repeatedly in these pages. Operative exsanguination was the chief reason for the two-stage interventions of earlier days of neuro-surgery when the anæsthetist's finger on the pulse, rather than ocular demonstration by blood pressure records gave the clue to the amount that the patient would stand The appended list of accurate measurements by H J Brennan on my own cases confirming J C

White's figures may help the reader to understand the necessity for caution Scalp bone tumour and brain can all bleed profusely

Nature of Lesion		*Blood loss in c c*
Frontal astrocytoma		915
Temporal astroblastoma		1102
Pituitary adenoma		709
		645
Parietal meningioma		987
Basal meningioma		1500
Falx meningioma		929
Acoustic neuroma		1162
Trigeminal neuralgia		162
		158
Parietal meningioma		987
	(2 days later)	1505
Cerebellar astrocytoma		946

The patients survived these losses but these figures compare strikingly with the 40 c.c. lost during the repair of an inguinal hernia or an appendicectomy Some of the more formidable general surgical operations notably radical breast amputation and some thyroidectomies cost over 500 c c Reduction of the blood volume by 800 c.c. (about ⅛th of the total) is well enough tolerated but some patients in poor general condition beforehand require transfusion after hæmorrhages no greater than this During long operations the insensible fluid loss from skin and lungs may amount to 2 000 c.c as J C White has shown but this alone is not a very serious factor though it must have some effect

Blood counts hæmoglobin estimations and blood pressure records should be made pre-operatively on all cases In patients who have vomited frequently and been unable to eat the blood protein and sodium tallies fall below safe levels hence the need when possible to feed an ill patient for a few days to correct this condition before operation During the operation systolic and diastolic pressures the pulse and respiration rates are recorded on a chart every ten minutes A graphic record is the only way of estimating the patient's condition with accuracy only thus can the surgeon forestall one of those precipitous drops in pressure causing sudden alarm. Blood transfusions must be used freely in one case recorded in the list above (loss 2 492 c c in 48 hours) the patient had five transfusions of between 500 and 600 c c each and survived.

The necessary speed in replacement can only be secured by careful planning beforehand Some tumour removals are easier after the blood pressure has fallen gutting a vascular tumour or securing vessels is made simpler when the force and speed of the blood flow is diminished But although all may go well with the systolic pressure at 80 or less the subject can no longer respond to a sudden hæmorrhage such as may mar the last stages of the dislodgement of a meningioma Not only must blood be waiting

in the theatre but the cannula must already be in a vein so that immediate restoration can be brought about The modern availability of blood has played no small part in the increased resources of neuro-surgery in dealing radically with tumours Even so the problem of hæmorrhage is more than one of emptying and filling the vascular system red cells tend to become lost as they do in shock and although transfusion will remedy a single bleeding it loses its effectiveness when the bodily resources are severely tried by repetition The ideal is to replace from the outset As a rule therefore a needle is put into a vein as soon as the patient has been settled on the table It can be used for replacement of blood or for glucose saline and is at once available for intravenous anæsthesia

Anæsthesia

The part played by the expert anæsthetist in recent years has been greatly expanded He has become more and more a partner in the general care of the patient assuming responsibility for the maintenance of his blood volume for holding the blood pressure at this or that level for the control of temperature and for whatever other pharmacological and physiological innovations may be in process of development in the operating room For this reason it is no longer possible to comment in a short space on the details of neuro-surgical anæsthesia

Local anæsthesia still has its place but it is in Britain at least a dwindling one being reserved commonly for the making of burr holes tapping of the ventricles cysts or abscesses especially in these last when the subjects are already unconscious or nearly so

Light premedication is an important aid to the induction of satisfactory anæsthesia but only those drugs can be used which do not dangerously depress respiration The morphia group is therefore not available Patients usually have about 8 grs phenobarbitone over night and again in the early morning Atropine is given 45 minutes before operation together with a small dose of heroin grs 1/12 maximum to 1/24 If the latter is not available pethidine 50–100 mgms hypodermically may be substituted.

In **general anæsthesia** the most important point to be observed is the avoidance of cyanosis because of the brain swelling that it so rapidly produces Conditions quickly then become the worst possible for efficient and safe neuro-surgery which requires (*a*) a good exposure (*b*) as slack a brain as the size of the lesion allows One must in the Mayos memorable phrase Make things easy for oneself for what is easy is generally safe Pharmacological developments have added greatly to the anæsthetists repertoire and to single out a drug as the best is a sure way of dating a piece of advice At the present day the Manchester routine is this (under the direction of Dr A R Hunter) —to rely chiefly on nitrous oxide oxygen given by endotracheal tube *together with a suitable supplement Intravenous* Pentothal or

Kemithal are best for this purpose Analgesic drugs may also be used in cases where the lesion has no tendency to disturb the function of the hypothalamic or medullary respiratory centres Trichlor ethylene (1·0 to 1 5 per cent) is a valuable supplement to nitrous oxide oxygen in cases which prove resistant to anæsthesia but the number of such patients can be greatly reduced if promethazine (Phenergan 25–75 mgms) or chlorpromazine 25–50 mgms orally is given 3 hours before operation

No matter what drugs are used for the maintenance of anæsthesia it greatly simplifies matters if Kemithal or Pentothal has been given for induction Tracheal intubation is usually done with the aid of suxamethonium (Scoline) Great care must be taken in the use of relaxant drugs for intubation in neuro-surgery because in an ill patient with respiratory embarrassment anything but the momentary suspension of respiration is dangerous

Hypotensive drugs.—For operations where hæmorrhage is likely to be unusually troublesome or what is worse dangerous—as is the case in the surgery of aneurysms angiomas and some meningiomas—controlled reduction of blood pressure down to about 60 mm Hg may be the greatest help The earliest attempts at this sort of planned hypotension were made by bleeding the patient to the required level citrating the blood and returning it to the circulation when the danger ous phase was over It is much more convenient to reduce pressure by the intravenous injection of a hexamethonium compound or the more quickly acting Arfonad The pressure is not reduced until the actual moment of danger is approaching as the lesion itself is exposed An aneurysm bursting on dissection is frequently not the formidable or even disastrous occurrence under hypotension that it once was and this technique has made the direct surgery of aneurysms a reasonably safe procedure The pressure is of course restored by methedrine the moment the dangerous steps have been completed

Hypothermia or "artificial hibernation"—The discovery that at low temperatures (26° to 30 C) not only does the blood pressure fall but tissues such as the brain whose metabolic requirements are high can be virtually deprived of blood by the temporary clamping of the chief arterial supplies has opened up new if conjectural fields Hypothermia probably has its usefulness but we do not yet know for certain what method is the best nor what are the risks The subject will be more profitably discussed in five years time Hypothermia can be induced by the administration of chlorpromazine in doses sufficient to prevent shivering while cooling the patient with ice bags or in ice-cold water

ANOXÆMIA AND HYPERCAPNIA

All four of Barcroft s types of anoxia are seen in cerebral conditions (1) stagnant anoxia where the blood current is slowed by local compression of vessels or by the surgical occlusion of large veins

(e g the parasagittal) in the removal of tumours (2) anæmic anoxia where the hæmoglobin content of the blood is too low to allow efficient oxygen carrying as in patients in poor general conditions or in those who lose excessive quantities of blood in the course of the operative procedures (3) histiotoxic anoxia when the cells are damaged and are unable to use oxygen as in some patients susceptible to barbiturates or patients who are dehydrated by vomiting or are otherwise toxic (4) anoxic anoxia which may be (*a*) generalized due to insufficiency in the available supply of oxygen as when breathing is too shallow or slow or (*b*) localized as when an area is surgically deprived of its blood supply but not excised. Some of these anoxic effects are primary others develop secondarily as the result of unavoidable surgical manipulations or from anæsthesia. A deficiency in oxygen in the blood either local or general increases the capillary permeability first to fluids and crystalloids later to the larger protein molecules and to the blood cells themselves leading to perivascular hæmorrhages. When generalized tissue anoxia damages everything brain lungs liver kidneys the endocrine glands when local, the effects are limited to the brain itself and its seriousness will depend on the area rendered anoxic. Thus if the motor area is anoxic, paresis results from the œdema set up if there is oxygen lack in the *hypothalamus mid brain* or *medulla a rapidly fatal hyperthermia* follows

The effects of increased carbon dioxide (hypercapnia) are more dramatic and temporarily more severe but fortunately more reversible. An elevation of carbon dioxide tension in the inspired air causes immediate swelling of the brain with vaso-dilatation the blood volume within the skull being considerably increased (as Forbes, Lennox Gibbs J C White *et al* have proved) Conditions of that kind are the worst possible for efficient cerebral surgery the cardinal principles of which are to have (*a*) a good exposure and (*b*) as lax a brain as possible Defects in respiration as in fourth ventricle tumours lead to insufficient ventilation in the lungs and accretion of carbon dioxide in the blood as well as to anoxia. Both anoxæmia and hypercapnia may exist independently

The physiological ill-effects of anoxia and hypercapnia sound so bad that the reader may wonder why any patient survives an anæsthetic or an operation. The facts are naturally that in their severe forms both are uncommon but they can be very frequent if their potentialities are not realized and the methods of reducing their incidence understood otherwise the surgeon will find himself ruefully puzzling over difficulties or fatalities that he cannot understand and which others do not seem to encounter

Operation in Stages

One-stage or two-stage operations.—The pioneers of the surgery of the brain usually operated in two stages cutting a bone flap or more usually removing the bone entirely (Horsley) one week and

dealing with the tumour the next week This practice has fallen out of favour because improvements in anæsthesia the modern prevention of hæmorrhage and the use of blood transfusion allow much longer sessions to be carried through successfully There are occasions when the operation is better done in stages usually for meningiomas But two things are necessary two very important things (1) that the wound shall be fit to re-open (2) that the patient shall be ready for the second stage in as good condition as he was for the first In my own hands the only cases deliberately staged have been meningiomas with X ray evidence of extreme vascularity or with large hyperostoses It is true that very occasionally I have found it necessary to break off an operation because of exceptional difficulties or an unexpected falling-off in the condition of the patient but these events cannot be reduced to dogma The chief concern in the staged operation is will the skin be fit for re-opening even if the greatest care has been taken? The answer is usually yes but the slightest morbidity or moisture causes anxiety If the operation is to be done in two stages when should the second stage be undertaken? There is no rule but one the sooner the better For instance a second stage has been performed in my clinic later on the same day (successful removal of a large meningioma by Rowbotham) or next day In one case a stage was done every other day for six days until an excessively vascular outer sphenoidal wing meningioma was removed with complete and lasting success These cases are mentioned to show that there is no hard and fast rule and that logically the patient is ready for the next stage the moment he has *recovered* from the last.

Length of Operation

At this date there is no need to defend careful surgery which must always be rather slow There is no virtue *per se* in taking a long time over an operation but the special difficulties of entrance and the necessity for extreme care in closing the wound demand time in neuro-surgical interventions It is easy enough to operate quickly but it nearly always entails roughness and corner-cutting which is gambling The spectacular operation appeals only to amateurs Nowadays only the uncommon case lasts for over 2½ or 3 hours and some can be done in much less time. The Halsted technique applied to neuro-surgery with such outstanding success by Harvey Cushing remains in the belief of many the best ever devised. It consists of extreme gentleness of handling absolute hæmostasis at all stages of the operation perfect apposition of tissues and the use of that ligature and suture material which causes least reaction in the wound iron-dyed fine waxed silk A perfect operation ought to look like a superb physiological experiment (as indeed it is) the object being to inflict the least possible damage on the patient whose recovery in the best imaginable condition is the essential object of the proceeding With modern methods of anæsthesia no harmful effects can be traced to the time factor except the possibility of infection and certainly a

very high standard of combined asepsis and antisepsis is needed. An occasional successful operation of ten hours has been reported. We may well marvel at the fortitude of the team but we should equally applaud the perfection of operating room management that made possible so long an exposure without bacterial contamination

Exposure—The Osteoplastic Flap

The approach to a hemispheral tumour must be made through a well placed bone flap To expose a tumour adequately it is essential to know its site beforehand as precisely as possible a requirement which not uncommonly necessitates angiography or ventriculography The flap must be not only correctly situated but of sufficient size to allow the manipulations proper to the individual tumour It is the bane of brain tumour work that the surgery of access and of closure is so tedious. Unless the approach is made according to well tried rules the approach may leave the patient unfit for the treatment for which the operation is planned. Mechanical and electrical aids have been devised which no doubt suit the requirements of the inventors but are rarely so helpful to anyone else. The most popular amongst them is the electrically operated drill of which the de Martel type is particularly good and ingenious. But all these drills are heavy or if they are not heavy are rarely safe and like all electrical equipments they are apt to get out of order In the end, after trying everything I am convinced that the hand-operated Hudson perforator and burr is the safest and most generally useful method of making the necessary openings in the bone.

Position of the patient.—All operations on the brain require a special table. It need not be elaborate or costly but only by its use can the surgeon obtain that comfortable and close approach which is a necessity Positioning on the table and on the head rest are most important Attention to detail must be developed in the highest degree if a high level of success is to be maintained. An example is the need for provision of much deeper padding on the table than is provided for ordinary short operations. Patients feel the effect of long recumbencies with full muscular relaxation on insufficiently protected surfaces The easiest position to arrange is that for the frontal flap for here the patient lies on his back with the head raised and slightly flexed When a lateral flap and especially one far back is required there may be difficulty in obtaining the necessary amount of rotation especially in the short necked or muscular individual. A sand bag under the shoulder and a quarter turn of the body towards the opposite side at once remedies defective rotation of the head Occasionally it may be a good plan to turn the patient on to his face in the cerebellar posture if an extreme occipital flap is needed. But the head often sinks so deeply into the head rest that good access to the anterior or temporal limb of the incision cannot be obtained. The patient can well be placed on his face and the head then turned to

the side on the head rest. This is the posture I use for extreme occipital hemispheral exposures Severe rotation of the head on the neck leads to compression of the jugular veins and raised intracranial pressure.

In general it is best to have the head raised higher than the feet to prevent venous engorgement. The more the head is up the better This necessitates an adjustable rest at the foot of the table that can be slid against the soles of the patient s feet to prevent him slipping down The legs must be strapped to the table above the knees to prevent them from bending

Details.—After proper positioning has been achieved there are three further things needing attention Nothing more clearly shows proper neuro-surgical training than attention to details preceding the intervention which may be wrecked by their omission First the eyes should be covered with a mask of petroleum jelly gauze or thin guttapercha tissue. Next both lower limbs must be bared To one the neutral electrode of the endotherm will be bandaged the other prepared over night, is exposed and towelled for intravenous transfusion. Often the introduction of a cannula into a vein at the ankle should be the first step in the operation The other important point is to see that the patient is properly oxygenated If intratracheal anæsthesia is being used there is no difficulty but if the operation is to be conducted under local anæsthesia comfort must be ensured Unless there is a free air way unless the nose and mouth are clear the patient soon becomes convinced that suffocation is inevitable The way to avoid this difficulty is to arrange a tray above the chest so that the towels can be carried from the head on to it making a tent. Wet drapes wrung almost dry out of 1 in 1 000 perchloride or 1 in 60 carbolic are always put next the skin They are used because they diminish the risk of infection mould themselves better to the head and cling to it more closely But if they are allowed to sag down on to the face they cause embarrassment The operating table should have an adjustable instrument tray fixed to it the towels are stretched on to it from the head In an emergency the surgeon can make do with a stand tray swung over the table but a properly fitted table should be used as a routine. At least two trained assistants are needed three is a better team.

Planning the flap.—The true osteoplastic flap is one in which the bone is turned down with the scalp adherent to it. (Fig 575 d) This is the classical procedure and a very good one especially for meningiomas which usually have considerable vascular connections with the soft parts overlying them It is used in the parietal temporo-parietal and fronto-temporal regions But no harm to the bone comes from stripping the skin down separately and then cutting the bone flap secondarily nor indeed if the bone is completely separated from its temporal hinge is lifted out as a free flap or graft and replaced later This is always safe. I have boiled and replaced such

a flap and many times the removed bone flap has been kept for days and often for several months sterile in a refrigerator and then successfully replaced. It is clear therefore, that in planning flaps the surgeon need not be absolutely restricted by the thought that either skin or muscle adhesion with the bone must be preserved.

(a) The Trotter flap —This (which is known in America as the Naffziger flap) was designed as a frontal flap but it can be used to expose anterior and middle temporal as well as frontal and pituitary tumours It is excellent also for sphenoidal wing meningiomas It can be varied in size at will. For the pituitary adenomas it can be

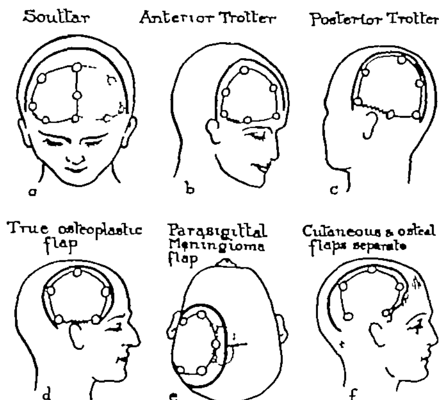


Fig 575 —The common skin incisions and bone flaps.

kept small whereas for more posteriorly situated lesions it can be made much larger by bringing its posterior limb down behind the ear (*See* Fig 575 b) The incision commences in the midline of the forehead an inch above the glabella. It may be started higher than this if there is no reason to expose the extreme anterior pole of the frontal lobe The incision runs back, precisely in the midline until the hair line has been well entered, and then swings away to be carried down in a curve to the temple in front or behind the ear according to the size of flap required. The scalp is dissected off the bone and held out of the way by retractors The bone flap is cut separately *The great advantage of this incision is that it does away with unsightly* scars on the forehead, the worst of which is one running obliquely

from the temporal fossa to some point between eye-brow and hair line So long as any incision is kept dead centred in the midline of the forehead and is carried up vertically the resulting scar is always insignificant The disadvantages of the incision are two The first is that it is difficult to get exposure low down in the temporal fossa without considerable retraction of the flap This has not been a sufficient difficulty to prevent me from using it freely The second disadvantage is the large dead space which results when a big flap is cut in this way for there is then more chance of post-operative wound infection

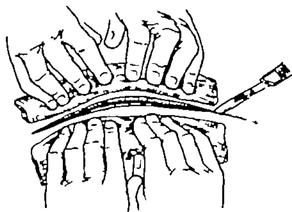
(*b*) **The Souttar incision.**—This is a coronal incision across the vertex from one temporal fossa to the other (Fig 575 a.) The anterior flap is then dissected down over the eyes A right- or left-sided frontal bone flap or even both may then be cut the skin incision being carried rather lower on the side of access to the tumour Its disadvantages such as they are are the same as those of the Trotter flap

Lateral flaps—For parietal flaps which are usually fronto-parieto-temporal the true osteoplastic flap was originally designed by Wagner As originally planned its omega form implied too narrow a base for the skin Necrosis in the suture line may follow And yet it is necessary that the base or pedicle of the flap should be fairly narrow otherwise the bridge of bone there cannot be broken through For that reason it has become customary to cut a semi lunar skin flap with a wide base making the bone flap secondarily with as narrow a base as the surgeon pleases (Fig 575 f) The only disadvantage is that implicit in the presence of two dead spaces one between skin and bone as well as the second unavoidable one between bone and dura (as in the flaps described above) My own experience is that there is less fear of infection with osteoplastic flaps but that the others are cosmetically better and quicker I use either but always the Trotter for frontal and sphenoidal ridge lesions

The occipital flap—A reversed Trotter does very well here. Occipital bone flaps are difficult to make because of the thickness of the skull and more particularly because of the antero-posterior curvature of the base which renders it very unwilling to break. It is necessary to leave a very narrow unsawn bridge of bone or else fracture strains the skull too much and is intolerable for a patient under local anæsthesia A true osteoplastic flap in this region is therefore most difficult but it can of course be done.

Preparation of the skin.—The head is shaved the afternoon before operation and after a thorough washing is prepared with alcohol and a sterile compress applied Alcohol causes less scaling than other antiseptics When the patient is anæsthetized the scalp is again washed with alcohol and allowed to dry Cushing usually had his patients shaved early on the day of operation as a newly shaven head interferes with sleep

Making the skin flap.—The projected flap is marked out by a wooden stick tipped with wool or a small dental swab dipped in iodine This allows the surgeon to make any amendments that may occur to him when he sees how it runs over the curvature of a particular skull. It is a good plan to draw a line down the middle marking the sagittal sinus and then to add the sulcus centralis and to rough out the temporal lobe. The line of intended incision is infiltrated with 1 per cent novocain-adrenalin solution injected above but chiefly below the galea. It is unwise to force the solution too much into the fibro-fatty substance of the scalp itself though some is placed there. The flap is now lightly marked out with a knife and a large piece of lint wrung out of 1 in 1 000 per chloride of mercury is placed over the head and sewn on to the scalp and the drapings are then applied. Those next to the head are always wrung out of antiseptic for this is safer in view of the long duration of some of these operations. (The eyes having been covered are protected from chemicals) The scalp must be completely exsanguinated by the pressure of the assistants fingers on either side of the incision (Fig 576 A) This is an art which requires some training A greater length than 7 or 8 cm. at a time is difficult to control As soon as the first length has been cut the galea is rapidly picked up by forceps roughly a centimetre apart and when these have been applied to both sides they are grouped together with rubber bands (*see* Fig 576 B) five at a time being the most manageable number A piece of dry gauze is placed in the incision and the manœuvres repeated until the whole flap has been cut In a well managed case there should have been next to no



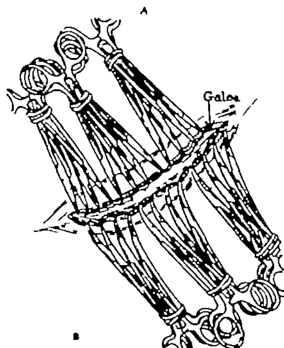


Fig 576 —Incision through scalp exsanguinated by finger compression. Below artery forceps picking up galea bundled with rubber bands.

bleeding during the making of the incision a most desirable thing because the scalp is so vascular that a great deal of blood may be unnecessarily lost during this relatively trivial stage—blood that may be very badly needed before the operation is completed and the patient safely back in bed. In a test-case of mine 50 c.c. of blood were lost during what appeared to be a very bloodless entrance and 800 c.c during scalp closure when the forceps were removed for suture The scalp flap having been cut the next step depends on whether a true osteoplastic procedure is intended or some modification. If the former all the parcels of artery forceps on the inner edge of the incision must be grouped neatly together and fixed upright with a long strip of gauze or rubber bands or both If the latter the scalp will be dissected down as far as required Search must be made for any vessels that have not been secured and any small bleeding points on the pericranium must be coagulated with the endotherm The proposed bone flap is next delineated by incising the pericranium with the cutting current and the membrane pushed to the sides with a raspatory to leave a fairway a good centimetre wide.

Cutting the bone flap proper—In general, a satisfactory bone flap is 5-pointed i.e. five drill holes joined with the Gigli saw (Fig 577 b) It is not a true pentagon for the bevelling of the bone edges by the oblique cut with the Gigli rounds its contours Generally it is wider than it is high The drilling is done with the Hudson perforator followed by burrs unless the surgeon insists on electrical apparatus The Hudson burrs are excellent but must be kept sharpened and (most important) kept tapered to prevent plunging through the skull. (Fig 577 a.) It is usual to make all the perforations first and then burr them out afterwards. Bleeding is prevented by wax and by placing portions of dental swab in each burr hole as it is made. The next step is to separate the dura with a curved dural dissector so as to secure a safe start for the guide for the Gigli saw (Fig 577 c) If there is any difficulty in introducing the guide it is best to sink other intermediate holes especially if the flap is over the sagittal sinus for the guide may be caught in a fold of dura. (Fig 577 e) The best type of guide is the de Martel made of watch-spring with a cover for the hook to which the loop of the saw is attached The new type of Stille Gigli saw is a remarkable instrument it rarely breaks and the bone can be cut with it in a few seconds. Sometimes there is very free bleeding from beneath the bone whilst the guide is in it stops if the guide is pulled out as soon as the saw is well sunk into the bone. Any bleeding from the line of the saw cut is diminished by forcing in bone wax

After all drill holes have been joined the lower ends of the incision in the bone are carried down beneath the temporal muscle with de Vilbiss forceps. The flap can now be broken back by levers inserted under the edge Bleeding commonly occurs from the meningeal vessels which are at once coagulated and from the parasagittal lacunæ if the flap is carried up to the midline. This latter bleeding

is important and must immediately be checked by strips of hot moist lintine which soon adhere and check the hæmorrhage. If however the bleeding is excessive owing to an underlying tumour or an impeded

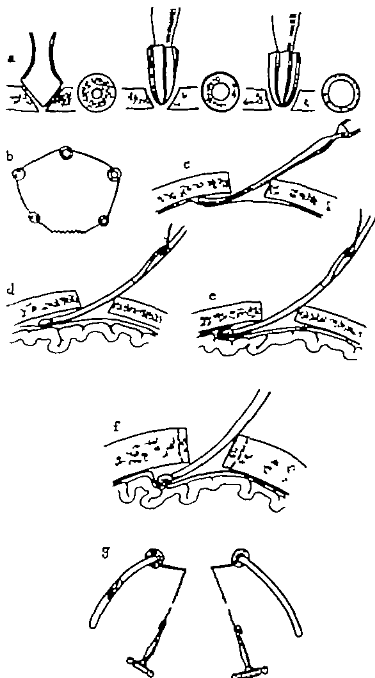


Fig 577 —The bone flap.
a, Drilling and boring. b, completed flap. c, separating dura. d, Gigli guide sliding in. e, guide catches in dural fold. f thick skull causes guide to enter too vertically g, joining burr-holes with Gigli saw

airway with venous congestion (the quality of this bleeding is informative to the experienced) fibrin foam or the Horsley muscle graft must be quickly applied.

By these means the hæmorrhage soon stops but a continued ooze may come from the dura just beneath the bone edges This can be checked by hitch stitches which pick up the dura a millimetre from the bone edge they are left long weighted by a pair of artery forceps These hitch sutures may have to be inserted at several points. At the end of the operation the dural traction can be made permanent by threading a needle on to the stitch again and passing it through the pericranium and tying it A groove may have to be cut in the bone to accommodate this suture but not always The dural surface should now be completely dry until it is it must not be opened The amount of blood lost up to this stage should have been little unless the patient has engorged dural sinuses or exceptionally vascular bone. The surgeon should pause for a moment to consider whether from what he has seen already and what he expects to encounter a blood transfusion will be necessary and when. It is rarely required at this point except in meningiomas.

Intra-cranial Procedures

Opening the dura.—The dura is incised transversely at the lower end of the incision. It is usual before doing that to nibble away part of the temporal bone below and also to shorten the bone flap to provide for decompression later In high pressure cases a ventricular tap is often needed before the dura is opened either by a puncture through a small cut in the dura or through a specially placed burr hole. This may be on the same side but at times it will have to be made over the ventricle of the opposite side in which case the anterior puncture is the most convenient (*see* p 1412) When ventriculograms have been made the same day the ventricles should have been tapped afresh before the anæsthetic was given When tension is judged to be sufficiently low the dura is opened freely If after a tentative incision an inch or so long the brain herniates so strongly through the opening that it disrupts something is wrong To continue the incision means that any part of the brain exposed by the continued opening of the dura will necrose. It needs some judgment and experience to know what to do next. A ventricular tap usually suffices to bring the pressure within manageable limits most relief comes when puncture reveals a cyst the evacuation of which greatly reduces pressure. If not help may be given by intravenous administration of 80 to 75 c.c. of 15 per cent. saline. If this also fails to improve conditions (and it may fail) the anæsthetic may be at fault either through an obstructed airway or through too-brisk secretion of cerebro-spinal fluid. It will then be best to wait and open under local anæsthesia on the next or any succeeding day for in the presence of very high pressure radical surgery is impossible. Modern methods of anæsthesia have reduced the frequency of these tense brains which seem to be more often encountered by the inexperienced.

In the majority of cases the dura can be opened widely and fashioned in a flap with its base upwards towards the sagittal sinus

It is a good practice to cut it through above as well if it oozes much though this can be left until the close of the operation Otherwise a post-operative clot will be very likely to form because of oozing from it Any meningeal vessels which bleed during the incision are secured with silver clips or the endotherm The latter causes the dura to shrink considerably so that it becomes difficult to close if it is coagulated much The remaining steps of the operation are directed at the pathological condition for which the operation is being performed

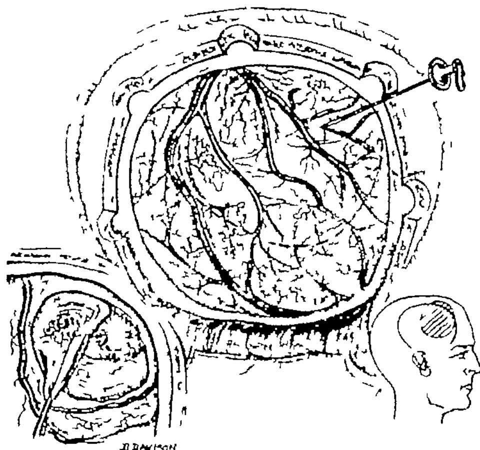


Fig 578.—Cystic astrocytoma. Dissection of cyst, exposing the falx.

Recognition of the neoplasm.—Ordinarily the gyri are convex and well vascularized by very fine vessels in the pia. They are separated from one another by the fluid-containing sulci in which arteries and veins are clearly recognizable the arteries in particular come to the surface for short distances to disappear again The vessels are misleading guides to cortical pattern for they often cross the gyri. Pressure for a few moments with a large piece of lintine makes the cortical pattern more easily recognizable. Excessively wide sulci firm convolutions and subarachnoid lakes of cerebro-spinal

fluid indicate local or general cortical atrophy Opacities in the leptomeninges are often seen in such cases but are not often significant of the nature of the lesion When on the other hand a tumour is present the sulci become narrow lines because the widened gyri of the overlying brain tissue are pressed together when the tumour is close to the surface there may be a faint yellow colouration Little if any cerebro-spinal fluid is to be seen and the cortex looks pale though vessels are still clearly distinguishable the veins are dark Sometimes the cortex feels soft over a tumour normally the gyri have a firm feel.

If the tumour presents on the surface its nature must be decided. If it is adherent to the dura it is most probably a meningioma though it could more rarely be a secondary carcinoma or an old tuberculoma Occasionally the malignant gliomas invade the dura but they are much softer tumours edged by small tortuous pial vessels containing bright red blood. There is little difficulty in recognizing a meningioma because of its hardness and well-defined margin sunk in the substance of the brain Meningiomas can however be soft they are unmistakable because of their greyish pink and circumscribed appearance and the well formed vessels to be seen on the buried surface when it comes into view as the tumour is being removed. The gliomas when not presenting on the surface—and often they do not—lead to a characteristic widening of the gyri over them

The presence of an underlying tumour is verified by introducing a brain cannula which will reveal a resistance or change in texture or enter a cyst An estimate of the tumour s dimensions and of its point of nearest approach to the surface can be obtained by making a series of careful punctures a few centimetres apart. Probe-like Geiger counters are now available allowing the detection of a tumour by the remarkable avidity which neoplasms have for radio-active phosphorus (P32) when it is given intravenously (T P Morley and G Jefferson 1952) The plan will always be to remove the tumour by dissection with wet lintine pledgets which find their way between the neoplasm and the surrounding normal brain tissue until the tumour can be rolled or lifted out.

Uncapping a tumour and lobectomy—It is often useful to uncover a subcortical lesion by removing a circle or oval of cortex from over it This uncapping (Cushing) is carried out after securing the cortical vessels by underrunning them with fine sutures by clipping them or by coagulation Care must be taken to secure the vessels at the bottom of the sulci otherwise the surgeon may be surprised by one of them Not until the wound has been deepened to a greater depth than the bottom of the sulci does the excision become entirely bloodless but as the tumour is reached a fresh but a different sort of vascularity is met a free bleeding from more primitive vessels It is better to uncap a lesion than to expose it through an incision because uncapping helps in decompression whereas incision alone may add to

bulk by œdema developing in the contused lips The surgeon may start with an incision alone and then convert the cortical wound into an oval excision 4 or 6 cm long by 2 5 cm wide when the tumour has been found.

Uncapping is only a step towards something more radical. If a cyst is opened a piece is cut out of the wall to allow of easier search for the tumour nubbin which has produced the cyst This, large or small must always be sought and removed Should the cyst be one

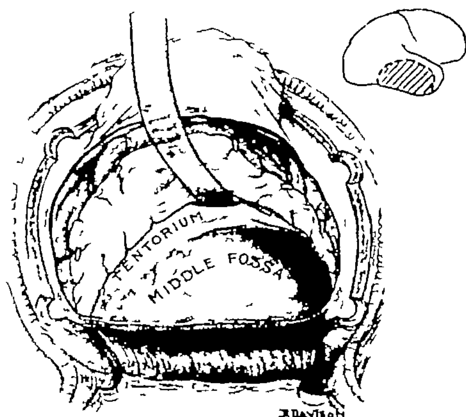


Fig. 579 —Internal decompression by lobectomy Right temporal lobe containing tumour excised.

of the rare kind that seem to have perfectly innocent walls a hole should be cut through the partition which separates it from the ventricle. (The ventricle can nearly always be recognized bulging into a cyst from which the contents have been withdrawn.) With a solid glioma *the amount removed depends on the nature of the tumour* as well as on its site It is impossible to lay down any rules except to say that as much tumour as possible should be taken out considering the situation of the lesion its vascularity its definition and the condition of the patient This is done (*a*) by pledget dissection (*b*) by suction (*c*) by piecemeal removal with the punch forceps or (*d*) with the electric endotherm loop Frequently all these methods must be used Suction is the quickest but it causes most blood loss and not all

tumours are soft enough to be lifted thus If the tumours cannot be dissected out entire the safest and slowest method is the use of the punch forceps especially when work is being done at a depth The electric loop is admirable for avascular tumours such as the fibrillary astrocytomas and for gutting meningiomas

Often the removal of a glioma is best performed by block resection that is by lobectomy Either of the frontal lobes can be removed without serious mental impairment provided that the opposite frontal lobe and the rest of the brain is normal The right temporal lobe may also be excised. (Fig 579) I have removed large portions of the left temporal lobe on several occasions without subsequent aphasia. The superior edge of the temporal excision should be a centimetre below the Sylvian fissure. Lobectomies give excellent results because the large dead spaces left behind (which fill partly with cerebro-spinal fluid partly by the expansion of the brain relieved of pressure) are most useful as regions of internal decompression What is more lobectomy most nearly approaches the surgical ideal of removing a tumour with a small margin of healthy tissue around it

Control of hæmorrhage.—The best methods of controlling hæmorrhage from the brain during excision are (*a*) silver clips (*b*) electro-coagulation (*c*) fibrin foam (*d*) muscle grafts Silver clips of the McKenzie type are advisable. In applying them it is best to make a minute cut in the leptomeninges at the side of the vessel for the pia is sometimes tough Electro-coagulation is excellent for veins The larger the vein the weaker should the current be Arteries vary in their susceptibility to coagulation depending on the amount of their adventitia and on the speed of blood flow It is often necessary to open up a sulcus deliberately in order to secure an artery Bleeding from the dura is well managed by foam or muscle grafts the latter taken either from the temporal muscle or from the leg Thin pieces of muscle about an inch square are crushed by hammering and held on bleeding points They can be more neatly used if they are stretched on guttapercha tissue which protects them from being brushed off or accidentally sucked off. Muscle grafts adhere very firmly after a few minutes Although we do not despise muscle much more use is made of fibrin foam or one of the manufactured gelatine foams Not only are these very effective but they are quickly at hand in emergencies without disturbance to the patient

Closure of the dura.—The dura is usually closed at the end of a successful tumour extirpation except below where a decompression is left beneath the temporal muscle (Fig 580 a) It is naturally very important to afford protection for the motor area if pressure is expected to continue (as after an unsuccessful operation) Otherwise a hemiplegia may be expected. It is equally a bad thing to leave a decompression of any size or maybe at all over a malignant glioma (glioblastoma multiforme) for it does no more than prolong a fatal illness If closing the dura means severe compression of the brain

it is best left open in whole or in part. The wise surgeon therefore only opens the dura in a high pressure case as much as the local condition calls for. This entails considerable experience in neurosurgery and the ability so to recognize the nature of the lesion as to estimate how much he can do before he has gone too far. Moderate tension can be overcome by slitting the dura up the middle after suturing the edges back.

Can the bone flap be left with nothing between it and the brain? The answer is a qualified yes. A new endothelial covering certainly forms beneath the bone but long before this develops there is great danger from cerebro-spinal fluid leakage and maybe from attrition of the cortex unless the bone surface is perfectly smooth and pressure low. A fascial graft from the thigh is excellent for closing large

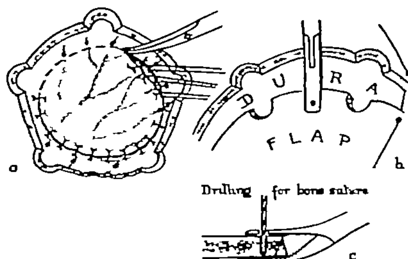


Fig. 580.—a, closure of dura which is finally cut all round to prevent post-operative bleeding.

b and c, drilling bone flap for suture (Adson's forceps)

defects in the dura and is preferable to leaving a wide gap or a piece of guttapercha can be laid over the cortex. The latter is very useful if the wound is going to be re-opened since it gives a quick and bloodless line of cleavage.

Replacement of the bone flap.—The flap is carefully and accurately replaced the bevelling of its cut edges prevents its falling in. Sometimes a drill hole or two may be made so as to fix the flap in position (Fig. 580 b) but this is unnecessary unless the exigencies of the case have called for the sacrifice of so much of it that it no longer fits accurately. Usually it is enough if the pericranium is pulled together in front, above and behind with a few stitches, the number varying with the possibility of doing it neatly and comfortably without undue tension. The cut edges of the temporal muscle must always be most carefully sewn together as this is a potential source of late bleeding

Occasionally the surgeon is unable to replace the bone flap at all without severely compressing the brain There is then no alternative to doing something that he greatly wishes not to do viz to sacrifice the bone flap It has to be stripped off leaving the temporal muscle and pericranium spread over the dura and this helps to give a covering I have already mentioned the fact that the bone flap can be set aside in a freezer and replaced when the swelling has subsided weeks or months later

Closure of the scalp.—The suture of the scalp is always made in two layers. (Fig 581) Harvey Cushing often said that the suture in the galea (epicranial aponeurosis) was the most important step that he had introduced into neuro-surgery This remark which somewhat belittles his other achievements is mentioned to emphasize that in some opinions the two-layer suture is vitally important. Certainly

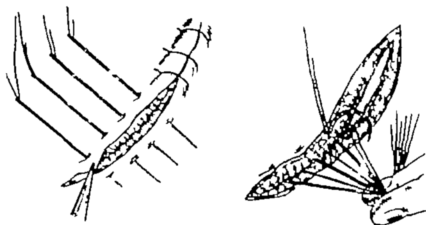


Fig 581 —Two-layer closure of scalp.

an insecurely or carelessly sutured wound can lead to cerebro-spinal fluid leaks cerebral fungus infection and death when more care would have obviated them Fine black waxed silk (0 or 00) is used the sutures placed at 1 cm intervals It is best to place a number before any are tied as the strain on each individual tied strand is considerable when the scalp is everted for the next suture. Nor must many of the artery forceps be removed at once or blood loss will follow the quantative importance of this has been mentioned It can tip the scales against the patient in the last minutes of a possibly long and exhausting operation The skin sutures are inserted with straight cutting needles and Cushing s method of inserting 6 to 12 of these before any are tied is a neat and useful idea (Fig 581) Finally the wound is washed over with alcohol and silver foil or paraffin gauze applied.

After-care.—The patient should be left on the table until there are signs of recovery of consciousness especially after cerebellar operations on those in poor condition I do not make this wait a routine step Often enough the patient recovers consciousness almost immediately

the nitrous oxide is stopped if not the intratracheal tube is left in until there are signs of discomfort from it. After it has been removed the patient must be watched for dyspnoea. A mouth tube may have to be introduced for a short time. Until consciousness returns he should be kept semi prone on his side to prevent the tongue falling back and to allow saliva to run freely from the mouth.

The patient should be nursed with the head raised as soon as his general condition will allow The practice of nursing patients after brain operations flat without pillows is barbarous It is extremely uncomfortable leads to cerebral congestion and bleeding and favours leakage of cerebro-spinal fluid Three pillows is the correct height a bed that can be wound up to an inclined plane is best If the patient has been dehydrated by vomiting continuous subcutaneous saline can be given during the operation This was a routine with cerebellar tumours in childhood and could be usefully adopted for selected adults as well. The patients can soon drink and there is no necessity to withhold fluids by mouth

In my own clinic nurses not only note down the pulse and respirations hourly but every two to four hours they add the temperature and blood pressure which they take themselves They also write down the state of consciousness of the patient and record the amount of fluid drunk In general surgery the exact hour of return to consciousness by the patient is unimportant but in neuro-surgery it is vital If it is not known there is no means of assessing whether a stuporose state is due to anæsthesia basal narcotics or blood-clot

Under basal anæsthesia the patients are usually quiet for the first two or three hours Later if they become restless small doses of codeine may be given gr ¼ being quite sufficient. It is best to err on the side of under-dosage Patients with intracranial lesions are far more susceptible than others to morphia which moreover raises intracranial pressure Chloral and bromide may be needed or even paraldehyde but only rarely is such medication called for Drains, if any are removed on the first post-operative day and the sutures on the third day unless there is much tension on the wound Careful inspection must be made for collections of fluid under the skin these must always be let out by insertion of a ventricular needle through the wound edge or by aspiration after puncture of the flap with a sharp needle In some cases punctures will have to be repeated daily or every other day if sanious cerebro-spinal fluid is finding its way under the skin a more likely happening when the skin flap has been dissected off the bone Lumbar or ventricular puncture may be required when post-operative progress is not as smooth as it should be Rises in temperature and pains in the neck and limbs indicate blood in the cerebro-spinal pathways and call for punctures usually lumbar But there is no necessity to do routine punctures on patients who are making good progress Ventricular punctures are not often needed except after some cerebellar tumours where it has been impossible to extirpate the tumour As an exceptional measure a

fine rubber tube may be left in the ventricle for a day or more and if the open end is carefully embedded in gauze wrung dry out of 1 in 20 carbolic dressings (Learmonth) infection rarely occurs

COMPLICATIONS

(1) Post-operative Epidural Clot

This is the most frequent complication fear of it causes the neuro-surgeon to spend time on his wound before he replaces the bone flap time that appears excessive to the uninstructed onlooker Thus a wound which looks perfectly dry may still form a clot that necessitates early re-opening and not until all the possible sources of bleeding known to the surgeon have been attended to can he rest content The only surgeons who never see these clots are those who never look or those who leave the intracranial tension higher than they found it It is an early complication for clot may form within six hours of the end of an operation after 48 hours it is rarer The source of the blood that forms the epidural clot is (a) the bone (b) the dura (c) the temporal muscle (d) most uncommonly the tumour bed

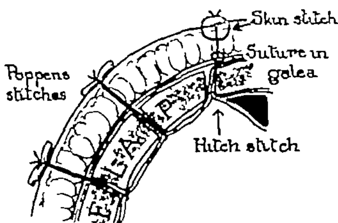


Fig 582 —Hitch stitches, to hold dura against bone to prevent oozing

(a) The bone is most likely to bleed in meningioma cases where its vascularity has been greatly increased. This can be prevented by going over the inner bone surface with wax but more particularly by stripping the bone off the temporal muscle until it is almost but not quite free. This is not always necessary it depends on the vascularity of the bone of which the surgeon has opportunity to form an accurate opinion from the X rays beforehand and from its behaviour during the operation The bone edges are waxed over as soon as the flap is turned down

(b) Hæmorrhage from the dura can be controlled by ensuring that the incision is carried round its exposed surface completely or almost completely so that vascular communications towards the midline are severed Bleeding points mesially can be secured with silver clips The hitch sutures described on p 1481 are most useful in preventing post-operative venous oozing and there has been a fall in clot incidence since their introduction These clots are most likely to occur in the best cases those in which so complete a tumour removal has been made that the dura tends to fall away from the skull or in those cases (such as pituitary tumours diffuse angioma

or epileptics) where intracranial tension was never high. A further plan is to make fine drill holes at several points through the flap and to pass sutures from the dural surface to be tied on the exterior (Poppen—*see* Fig 582) This obliterates the dead space between the dura and the bone and makes the formation of a clot almost impossible. If a downward slit is made through the dura beneath the temporal muscle to afford a decompression at the end of the operation care must be taken to see that no bleeding has been started up from the posterior branch of the middle meningeal artery

(*c*) Bleeding from the temporal muscle ought not to occur if the vessels have been properly secured Infiltration of the muscle with novocain-adrenaline solution may temporarily produce dangerously avascular muscle A very significant sign of clot formation is considerable swelling of the face or eyelids the day after operation. This *does not always mean bleeding that will require re-opening of the* wound but it should put the observer on the alert The really certain indications are increasing drowsiness or hemiparesis Convulsions are less common and unilateral pupillary dilatation is rare It is much better to re-open the wound than to sit too long wondering whether to do it The wound can be quite rapidly re-opened under local anæsthesia the clot removed and such further steps in hæmostasis carried out as the local conditions demand. Usually if the wound is re-opened soon the prognosis is excellent

(2) POST-OPERATIVE CEREBRAL ŒDEMA

Cerebral œdema can cause much the same picture as that of epidural clot. It is very likely to develop in cases where the dura has been widely opened and the tumour not removed, whether that tumour be a glioma or a meningioma. Its cause appears to be anoxia (*see* p 1421) It is treated first by restricting water intake to 30 oz in 24 hours and by magnesium sulphate enemata, sometimes with lumbar puncture in addition Intravenous glucose or better sucrose (50 per cent.) is sometimes given. In its worst form œdema causes hyperthermia and death. It seems to come on very rapidly does great damage and then very slowly subsides It is doubtfully wise in the present state of our knowledge to force fluids on brain tumour patients hence intravenous saline can only safely be given in any quantity if the patient is dehydrated. The only proper substance for intravenous administration is blood or plasma because of the salts and proteins they contain.

(3) CEREBRO-SPINAL FLUID LEAKAGE

This sometimes occurs even after the most careful closures but the surgeon should always feel it as a reproach It is most apt to occur when wounds are not early enough or carefully enough inspected after operation. Dressings with dry carbolized gauze are the proper applications or if there is any sign of gaping of the wound edges fresh sutures

should be inserted. Otherwise the leak may develop into a cerebral fungus once the bugbear of neuro surgery Such complications are rarer since it became the rule to sew up the dura at the end of the operation

(4) INFECTION

Now and again infection creeps into the most impeccable technique. Nothing seems harder than to trace a wound infection to its source but most often it comes from the mouths or throats of those around the table. All visitors as well as those engaged in the operation must be furnished with masks impervious to droplet penetration of which the best is the cellophane type. It is now recognized that the incidence of infection rises with the duration of the operation the number of persons in the theatre and the amount of movement (Cairns) Individuals moving about rapidly disturb the atmosphere and lead to an increase in the number of colonies culturable on agar plates exposed for test near the wound. Clots are the next most dangerous potential centres of sepsis. Infection rarely occurs in the snug wound those leaving a dead space—intra ventricular operations lobectomies posterior fossa explorations—are most liable. Slight morbidity in the wound edges is a flaw but is not dangerous unless the wound is to be re-opened for a second stage a step which the mildest infection forbids. Imperfect wound healing may be due to the long-continued compression of the scalp edge by the weight of the artery forceps This can be prevented by carefully packing gauze strips under the forceps to increase their pull on the galea without pressure on the skin. The utmost care must therefore be taken in all intracranial operations to obtain perfect healing hence the use of inner drapings moistened with antiseptic the careful shutting-off of the wound and sewing the drapes to the skin so that they cannot slip during what may be a long session and gentleness in handling tissues. The virtue of the true osteoplastic flap in minimizing the risk of infection has been noted.

The treatment of infection follows general surgical principles The antibiotics are matchless for their efficacy against organisms sensitive to them but it has been a great difficulty in neuro-surgery that it is by no means easy to culture identify and test the sensitivity of the causal organisms. The worst infections are those induced by gram negative organisms or pyocyaneus. Experience has shown that the most effective treatment is obtained by the use of the sulphonamides because of the wide spectrum of their anti bacterial actions A high level of the drug in the cerebro-spinal fluid must be rapidly obtained and the only way of ensuring that is by intravenous treatment The level aimed at must be at least 20 mg per cent. in fact less than that is little use (R T Johnson) This means that 8 grm. say sulphamezathine must be given four hourly After the first 24 hours doses are related to the sulpha tally in the cerebro-spinal fluid.

THE DIFFERENT TYPES OF TUMOUR

Malignant Gliomas

Although I have advised that no malignant tumour should be attacked unless there are special reasons for thinking that it can be completely removed it is proper to add that this is a counsel of perfection. Experience certainly helps greatly in the pre-operative detection of tumour types. At times a surgeon may find himself committed on a clearly hopeless case to steps much more lengthy and ambitious than he approves The abdominal specialist does not have to face this problem. When an abdomen filled with malignant metastasis is opened it can be immediately and rapidly closed and the case is unaltered. But when a malignant brain tumour is laid bare such swelling may occur as to necessitate the removal of a great deal of the growth before the bone flap can be replaced. The surgeon who says that in such a case nothing should be done is talking theoretical sense but practical nonsense. For either the bone must be peeled out and the dura left widely open when a huge protrusion will develop and the patient s crippled life be preserved long after his usefulness is over Or else the bone flap must be forced back when he will surely die within a few hours. A well planned excision of the tumour will obviate both these difficulties experience proves that the post operative mortality of excision is lower than that of decompression and occasionally these patients are able to lead useful lives for a time and then die after a relatively short terminal illness Internal decompression by a lobectomy is the ideal at which to aim.

Parasagittal Meningiomas

A tumour that calls for special comment is the meningioma (dural endothelioma of older writers) The apparent origin of many of these tumours from the arachnoidal villi means that they appear in the immediate neighbourhood of dural sinuses (especially the para sagittal lacunæ) into which these villi project. The sites of election are now well known (e g parasagittal olfactory groove dural convexity sphenoidal wing tuberculum sellæ falx tentorium petrosal sinuses clivus)

Pre-operative care.—This includes not only routine examination of the patient but also very careful study of the radiographs to ascertain the degree to which abnormal vessels in the diploë can be recognized. The surgeon knows that if the tumour is a meningioma he is going to face hæmorrhage and he must be prepared to combat it and compensate for it It will be necessary therefore to observe whether there is any region of special vascularity that may call for slight variation in the routine making of the osteoplastic flap It will be necessary also to provide blood donors. So important indeed are the latter that it is wise never to begin an operation on a meningioma without 600 c.c. of blood ready at hand and more to be had at short notice. Hence that statement I have often made that the first incision in a

meningioma case should be at the ankle to uncover a suitable vein In all intracranial operations it is more convenient to use a vein in the leg for transfusion rather than in the arm

Where there is no discernible alteration in the vascularity of the skull or meninges it may not be necessary to carry precautions quite so far But experience teaches that it is much better to be properly armed beforehand than to have to improvise reconstructive aids under duress. In any case in which considerable bleeding is anticipated it is most important that the air way should be completely unobstructed another important thing is to raise the patient s head It is possible with a suitable head rest so to place the head that it is postured almost as if the patient were sitting up Should occasion demand the tilt can be altered

Shall the operation be concluded in one single stage or in more? This question has already been touched upon as a generalization (p 1422) If there is exceptional vascularity in the radiographs this decision can be left until the bone flap has been cut On occasion the hæmorrhage encountered may be far in excess of anything anticipated so that the surgeon is compelled to break off his operation This is best done before the dura is opened (unless ventriculograms have just been made) or after the dura has been divided around the edge of the tumour But if the dura is opened and the tumour not removed severe cerebral œdema is very likely There is rarely extreme urgency in meningioma cases and even if the operation is done in stages there is no need for much delay The remaining part may be done in a few hours or a few days.

The incision —In dealing with a parasagittal meningioma it is always essential that the superior longitudinal sinus should be uncovered The bone removal must therefore transgress the midline. (Fig 583 a) The point is whether it is a good plan to make the flap primarily to cross the midline or to go almost up to the midline and then to uncover the sinus by nibbling further bone away I much prefer the latter method the only disadvantage being that a small gap is left where the bone has been removed. On the other hand the sudden uncovering of a length of the sagittal sinus when a bone flap is raised from over it may lead to furious hæmorrhage though it does not always do so and the anterior third of the sinus can safely be uncovered by the primary flap Since the surgeon cannot tell what will happen it is safer to use the more cautious method. The incision is made in the usual way but with special care to prevent blood loss the advantages of a true osteoplastic flap for meningiomas have been mentioned. There may be considerable bleeding from the bone when the burr holes and saw cuts are made and bone wax must be freely used even if the waxed point in the bone has to be removed shortly afterwards. Characteristic of the meningiomas is unusual bleeding when the pericranium is exposed and reflected from the bone to make a pathway for the saw cuts Bone wax must be rubbed on the bone

probably speed in making the flap is the most valuable asset. But there must be no hurry for the top arc of the bone flap needs making most carefully especially where it nears the sinus

Adhesions and the irregularities caused by parasagittal pits in the bone pits occupied by venous lacunæ make it difficult to separate the dura. The way to overcome this is to sink an extra burr hole or so If the dura, even then with very short distances between each hole cannot be safely separated the holes should be joined by nibbling

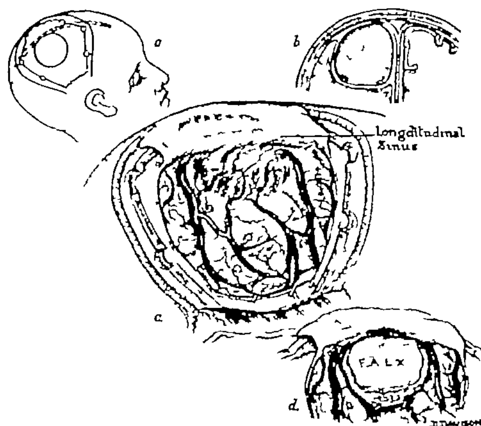


Fig 583.—Parasagittal meningioma, the common, largely buried type
a, Skin and bone incision crossing midline. b, schematic cross section. c, the undisturbed tumour. d, tumour bed after removal.

with Wilm s forceps An advantage of this method is that it leaves a wide enough gutter for bone wax to be inserted, a difficult matter through the narrow line of the saw cut When the flap is completed the surgeon must weigh the case up again by reference to the blood pressure chart It is at this point that a transfusion may have to be given that is before the flap is elevated. If blood has to be given at this stage it is almost certain that more will be needed later

A decision to continue having been arrived at the bone flap is broken down and squares of wet lintine (6×8 cm.) are instantly placed over the sinus and held there They must not be pressed on too hard

or the sinus is pressed away from the bone and may bleed from fresh and inaccessible places When the bleeding has stopped the lintine is replaced by fibrin foam over which first sterilized guttapercha tissue and then lintine again is laid. The rubber prevents the lintine from sticking to the grafts It is best to do this before the dura is opened for the replacement of the one by the other may cause such bleeding as to destroy the circulatory balance once more More bone must now be removed medially to expose the sagittal sinus opposite the attachment of the tumour A small extra skin incision (making it a split ring) may have to be added to allow this (Fig 575 e) The middle meningeal artery and its branches are coagulated as early as possible and the inner surface of the bone flap waxed over and considerably stripped from the muscle to stop oozing All bleeding having been arrested the wound is closed off by fastening green towels to the wound margins with Michel clips

The dura is now opened not in its whole extent but close around the outer edge of the tumour which can as a rule be seen or felt. This will take some time to do because the dura is always very vascular and requires coagulating or the application of silver clips at many points Once the dura has been incised around the tumour the most anxious moments are over and the remainder of the operation can be carried out with ease (Fig 588)

The extent to which the tumour is attached along the midline varies sometimes it may be only for a centimetre more often for 3 or 4 cm Another important variable is the consistency of the tumour itself this depends on its histological structure. The easiest are the hard smooth fibroblastic type the most difficult the soft lobulated meningothelial type and the angioblastic

The method of removal depends on the toughness of the tumour and the ease or difficulty with which it can be detached along the midline. When its attachment is narrow and the tumour hard it is easiest first to free the tumour around its outer circumference and then elevating it from its bed to tilt it across the midline. Its pedicle can easily be cut through after coagulation If the sinus bleeds the edges must be closed with mosquito-forceps Two or three fine silk sutures will close small gaps in the wall they can be made more secure by covering them with fibrin foam If the tumour is very large its elevation must damage cerebral tissue for the greatest width of the tumour is frequently buried. It helps to minimize cerebral trauma if the tumour is gutted (reduced in size by the electric loop) before any attempt is made to extricate it. An exceptionally vascular tumour should be desiccated by bipolar diathermy before its interior is scalloped out But since recurrence of meningiomas is certainly due to seeding the broken tumour surface must be well endothermized to kill potential transplants A large tumour may by this method be elevated without causing as much cortical damage as it would otherwise do Where there is a wide attachment of the tumour to the sagittal sinus the tumour cannot be safely swung up on its pedicle. The attachments

to the midline must be divided as the tumour lies *in situ* This is most easily done by free use of the blunt hook and the diathermy applied to its handle. The tumour once freed along the midline can be gently pulled up by sutures inserted in it wet lintine pledgets being used to sweep brain tissue off it and to line the bed temporarily All vessels crossing from the cortex are obliterated by diathermy and cut first the large superficial veins beneath the arachnoid later those deeper placed vessels crossing in the tumour bed.

The final connections of the tumour having been carefully divided

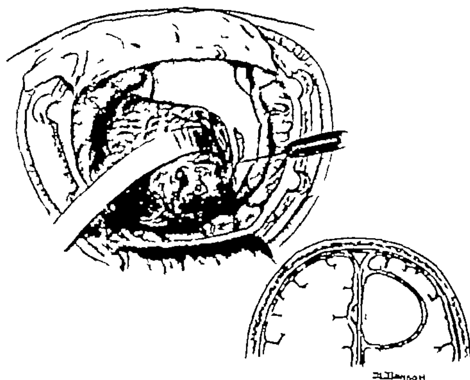


Fig 584.—Meningioma of falx. Observe tumour local invasion sprouting through falx, a button of which must be removed.

the tumour is lifted out and the jugulars are compressed by the anæsthetist to induce venous bleeding so that any unnoticed potential source of hæmorrhage may be secured. Muscle grafts are laid along the sinus and the wound filled with Ringer s solution If part of the bone flap has been invaded by tumour this part is best cut away with bone forceps. An alternative method is to diathermize it heavily whilst a finger on the outer side judging rise of temperature protects the scalp from undue heating The flap may be removed boiled in saline and replaced I have done this but it is not an invariably safe plan The defect in the dura should be repaired at once by a fascial graft for there is commonly considerable loss of dura in meningioma removals since the whole area of attachment must be sacrificed. A few

hitch stitches are placed and the bone flap replaced with a drain leading out from behind it Care must be taken not to lose blood from the scalp when it is sutured because blood is being badly needed by the patient at this stage. It is possible to remove most parasagittal meningiomas fairly quickly and relatively easily if they are set on methodically Some can be very difficult The meningiomas of the convexity are much easier for they do not have to be dissected off the sagittal sinus In that case the only concern arises from bleeding during the actual exposure of the tumour rather than during its elevation

MENINGIOMAS OF THE CRANIAL BASE

The general principles are the same but there are special difficulties because the attachment of the tumour to the dura is reached last instead of first Further all these tumours are buried beneath the brain which cannot be elevated if pressure is high so that various types of excision of a frontal or a temporal lobe must be the first step These tumours present the most formidable problems in the whole range of the surgery of benign or quasi benign neoplasms. The reader is referred to special monographs for detailed operative description

DECOMPRESSION

We owe to Horsley the decompressive operations which were originally performed to reduce headache and relieve the optic nerve-heads of papillœdema Nowadays they are more often the by products of partial tumour removals or negative explorations and what was once the commonest of all neuro-surgical operations is now rarely performed as an end in itself This change is due to (*a*) more exact localization of tumours by ventriculography (*b*) a better understanding of their nature and life history The result is that the surgeon feels much more confident of finding a suspected tumour and of doing something worth while with it. The cranial cavity is the only place where even a subtotal tumour removal is of considerable benefit to the patient

It is a mistaken notion that a patient who is unconscious and has a tumour is in that state from high intracranial pressure alone Confused thinking on this point led to the conclusion that miraculous cure would follow a decompression These desperate states are usually due to destruction of neural tissues by malignant tumours and pressure plays a relatively unimportant part This is especially true in persons past middle life (when glioblastomas and secondary tumours are so common) It will be realized that merely to decompress a benign tumour would be a work only part done

Decompression then should be reserved for the following —(*a*) for serous meningitis where there are pressure changes and danger to vision from choked discs but no actual tumour (*b*) as a step to reduce pressure in a patient known to have a removable tumour (such as an olfactory groove meningioma) but where the pressure is so high that it will make removal impossible (*c*) as a safety measure at the close

of most tumour removals in order to allow for traumatic œdema (*d*) as a stage in the treatment of the encapsulated cerebral abscess (*e*) very rarely to relieve pain in malignant and otherwise inoperable gliomas morphia is a better therapeutic means

A decompression may be supra or infra tentorial but because most cerebellar tumours are benign operation by the suboccipital route will rarely be purely decompressive. If it is it takes the form of one of the usual cerebellar approaches The supra tentorial decompression differs from operations for tumour by being purely per temporal.

In 1905 Cushing published an account of the right sided sub-temporal decompression It was right-sided to avoid the aphasia which is apt to follow prolapse of the left temporal lobe it was low to avoid herniation of the motor area it was beneath the temporal muscle to obtain as much covering as possible for the otherwise unsupported brain The importance of these points can only be properly appreciated by the surgeon familiar with case after case of high pressure. Woe betide him who thinks that the steps of the modern surgical closure are over-elaborate and unnecessary

Sub-temporal Decompression

Any decompression is most effective when it is placed over the actual tumour Hence the sub-temporal operation is best theoretically for right temporal tumours for a tumour always tends to drift towards the low pressure zone (Trotter) and may cause neurological signs to appear that reveal its hitherto unknown site (Cairns) It must never be done for a subtentorial tumour for it then relieves pressure very little the hydrocephalic ventricle blows out the temporal lobe without lowering the pressure very much and causes it to necrose. This happens indeed in all herniations under high pressure hence the need for careful selection of a silent area and the protection of those with important functions The original horse-shoe or omega flap has been given up because it entailed severance of the frontal branches of the facial nerve A large question mark incision is made convex backwards commencing 8 cm above and behind the external angular process following a course 1 cm or so above the temporal crest The scalp is cut with the routine technique for hæmostasis and dissected off the temporal fascia downwards and forwards as low as possible. In the classical sub-temporal decompression the fascia and muscle were next split vertically and the bone removed from beneath. In practice this proves to be a very difficult procedure and usually ends either in an opening so small that it was hardly worth making or in the muscles being pulled about so much that they are difficult to suture. It is better to make an incision 1 cm above the temporal crest and most carefully rongeur the pericranium downwards as far as the muscle attachment and then scrape it from the bone the whole in one large and undamaged musculo-aponeurotic sheet. Four artery forceps applied to the edges keep it under tension so that it does not shrink A hole is now drilled in the bone and the temporal squame is nibbled

away downwards to the floor of the middle fossa The most useful forceps are Horsley s Wilm s Trotter s and the double-acting Stille type. The opening should be centred above the pinna If it is carried too far forwards the decompression causes an unsightly bulge which no head-dress will hide. A bone opening some 6 cm high by 6 cm long is desired. After coagulating the meningeal vessels crossing the exposed dura and waxing any bleeding from the bone the wound edge is sealed off with fresh towels the gloves changed (because tears or punctures are likely in all work on a substance as hard as bone) and the dura incised It can be opened the whole length of the incision according to the technique described on p 1481 but it should not be opened higher than the Sylvian veins which are very easily identified If pressure is great a ventricular tap should be made through the second temporal convolution in the posterior part of the decompressive opening or through a fresh burr hole at Keen s point—3 cm above and 3 cm behind the external auditory meatus Bleeding from the dura is now controlled and after washing over with Ringer s solution the temporal musculo-aponeurotic sheet is sutured back with multiple points of fine silk 1 cm. apart The skin is closed in two layers as usual. I have occasionally cut a small flap in the temporal region instead of performing the operation just described but although it is an entirely satisfactory method superior to the intermusculo-temporal it is no better than that here described.

The results of pure decompression for tumour are worse than attempts on the lesion itself. When the tumour is temporal a lobectomy is better because of the increased space afforded to the brain— internal decompression (*see* Fig 579 p 1488)

THE CEREBELLAR APPROACH

The original unilateral approach was bad for all posterior fossa tumours except the acoustic neurinomas partly because it did not allow a sufficiently free exposure but especially because it did not provide relief for tonsillar herniation. The need for decompression of the medullary centres caused Harvey Cushing to introduce the cross bow incision (*see* Fig 585 a) The vertical limb made it easy to remove the arch of the atlas and the lamina of the axis too if need be whilst the transverse part of the incision was carried so widely to the sides that a very full and free exploration not only of the vermis but also of the cerebellar hemispheres was possible. The great dis advantage of this incision is the time necessary not to make it but to close it so that it has generally been superseded by a plain transverse incision representing the horizontal part of the crossbow Equally the vertical part alone can be used but it is more useful for children in whom a midline lesion is probable. Special incisions are necessary for posterior fossa operations requiring good exposure of the cerebello-pontine angle and will be described in their proper places (e g for acoustic neuromas trigeminal root section)

The classical crossbow incision entailed an incision across the occiput 2 cm or so above the cranial attachment of the nuchal muscles These were cut across just sufficiently below their attachment to leave a fringe for suture at the close This was the modern cerebellar incision but the midline bids fair to replace it (I mean the central part only of the crossbow extended further upwards) It is rather easier to dissect the flap down so as to uncover the atlas if the incision crosses below the inion instead of above it but a good deal depends on the shape of the occiput and the low transverse incision is most useful in patients who have a shallow posterior fossa and an unusually prominent external occipital protuberance Another incision again

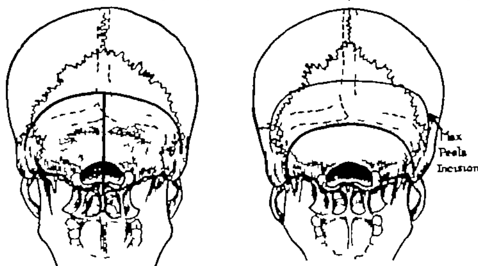


Fig. 585.—Cerebellar Incisions.

is a higher one still in which the muscles are not cut at all but are taken down in a musculo-aponeurotic sheet (Peet Fig 585 b)

The preparation of the patient and the anæsthetic are as before save that endotracheal gas-oxygen trilene anæsthesia except in grave emergencies is a routine for these operations They are bad to do under local anæsthesia for the position is a very trying one for the patient and the muscles are difficult to re-suture. Also if the subject has been heavily dosed beforehand his breathing will very likely become obstructed requiring an intratracheal tube. I believe that it is best to decide on general anæsthesia as a routine for anæsthetic amendments are harder to make in the course of cerebellar than in any other neurological operation

Posture for cerebellar operations.—The patient lies face downwards with the head supported in a horse-shoe head rest of adjustable height It should be of a type allowing flexion and extension of the head by altering the angle of the head-rest with its support and allowing also of rotation to either side for work in the cerebello-pontine angle.

Ordinarily, the ideal is to have the head flexed just sufficiently to make the sub-occipital region as accessible as possible and to put the nuchal muscles mildly on the stretch. Overflexion of the head on the neck leads to congestion At the close of the operation it will be necessary to reduce the flexion so as to relax the muscles for approximation by suture The patient s shoulders must be supported in Cushing s shoulder rests but even this is not sufficient to give freedom to the chest and abdomen for easy breathing A sand bag should be placed under the pubes to lift the abdomen sufficiently for free respiration The table itself must be very well padded the usual sorbo mat is not thick enough A special mattress or pillows are better If the surgeon tries the position himself he will soon learn the little tricks necessary for reasonable comfort during a long operation. Latterly I have become increasingly impressed by the advantages of the sitting posture for posterior fossa operations In this position respiration is free and easy so that the cerebellum when exposed is under much less pressure and is readily retracted and inspected its upper surface can be seen. High vermis tumours are more readily dissected out when the patient is upright because a better view is obtainable The venous pressure is so low that a nick in the wall of the transverse sinus may not be recognized and air sucked in If the anæsthetist compresses the jugulars open veins are at once detected The risk is only present on the approach stage but that it exists must not be overlooked I have seen air embolism happen but fortunately without disaster

The operation.—The first step in the operation used to be the puncture of a lateral ventricle but as Cushing who introduced it in 1909 pointed out later it has the disadvantage of causing such a lowering of pressure that the structures in the posterior fossa fall back into normal station so that even a largish tumour if it is deeply placed may escape recognition. For that reason it is better not to make the puncture unless there is good reason i e congestion and severe venous oozing (occasional) or unless the dura is too tight to be safely opened (rare) Ventricular puncture is simple when a cerebellar tumour is present because the ventricles are enlarged but if the patient lies face downwards with the head slightly flexed the operator must take care not to lose orientation It is therefore wise before the drapes have been placed, to mark with iodine not only the site of the burr hole proposed for the ventricular puncture but also to draw a line running towards the glabella After the ventricle has been found and the cannula introduced the ventricles are decompressed slowly to diminish venous engorgement and aid respiration

Incision—The skin incision crosses from mastoid to mastoid immediately above (more rarely below) the external occipital protuberance and when it reaches the mastoid processes it curves downwards to end about the level of the mastoid tips just at the hair line The incision is made with the usual precautions against

blood loss The occipital arteries can be picked up and tied separately When all artery forceps on the galea have been neatly bundled the lower edge of the incision is dissected down until a clean incision can be made with the endothermy cutting current through the muscles directly down on to the occipital bone for the whole length of the wound By the same means aided by a sharp rougine the muscles are separated downwards in one unbroken sheet to the foramen magnum and far out to the sides. Skin and muscle in one flap its thickness depending on the muscularity of the neck are retracted inferiorly till as much as can feasibly be bared of the squamous portions of the occipital bone is in view This dissection can be elegantly done with the cutting current keeping dead on the bone. In children the separation is remarkably easy in the muscular adult it is more difficult for tendinous slips arise from well-marked ridges and pits in the bone. The operation is always difficult in a patient whose occiput shelves forwards very sharply easiest in those in whom it makes a nicely rounded bulge Wax always has to be used to block up the emergent veins from the diploë especially in long standing high pressure cases. The muscles are fully dissected down first to the foramen magnum and then beyond it in the midline only in order to allow laminectomy of the atlas (Removal of the atlantal posterior arch is to all intents and purposes part of the routine of any cerebellar exploration and decompression—so common is tonsillar herniation.) The tissues are readily and bloodlessly dissected bluntly off the occipito-atlantal ligament and then the atlas is cut down upon. Considerable retraction is needed to bring it in view and sometimes a short (4 to 5 cm) vertical incision must be made converting the approach into a crossbow The arch is cleared and 3 cm of it nibbled away either now or after the occipital bone has been removed

If a midline incision is used it should run from 5 to 6 cm. above inion down to the third cervical spine The cut is deepened to the bones and the muscles separated as widely as possible from the occipital squame without dividing their attachment to the occipital crest Powerful self retaining retractors maintain good exposure.

Next a drill hole is made on each side of the midline of the squamous occiput and the bone widely removed this is sometimes very easy for it may be paper thin. There is risk of the drill plunging so that the holes are best made in the thicker bone just below the transverse sinus A very free bone removal should be made including the margin of the foramen magnum laterally out to the mastoids and superiorly to the transverse sinuses The full exposure of the sinus of one side for lateral recess operations is described later The bone bleeds most in the midline below the torcular but oozing is easily checked with wax blood may come from the exposed dura oozing down from above (stopped by tucking a muscle graft up under the bone edge) or from the inferior occipital sinus (stilled by coagulation) The surgeon must beware of injuring the posterior condyloid veins the mastoid emissaries are only endangered when a very wide exposure

is made The wound should now be dry and until it is the next stage must not be embarked upon Fresh towels are clipped to the wound edges and then the dura is opened.

Dural incision.—A small incision is made over the left cerebellar lobe and a narrow piece of lintine pushed underneath to protect the cerebellar cortex from being cut by the side of the scissors blade The dura is opened by an incision that curves downwards and crosses the midline about 1 cm above the level of the foramen magnum (*see* Fig 586) The inferior occipital sinus is divided in the course of this sweep but it is easily controlled by electro-coagulation beforehand or by applying silver clips Finally this sinus is turned upwards out of harm's way and fixed so that it cannot bleed again

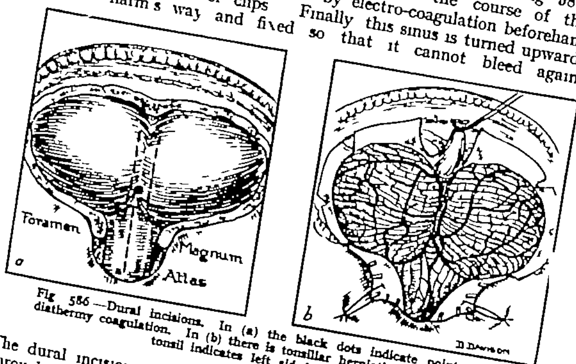


Fig 586.—Dural incisions. In (a) the black dots indicate points for diathermy coagulation. In (b) there is tonsillar herniation enlarged left tonsil indicates left sided tumour

The dural incision is now carried down vertically in the midline through the occipito-atlantal membrane and onwards through that part exposed by the removal of the arch of the atlas Three or four silver clips will have to be pressed on to the cut edges here The surgeon can often tidy up his wound and prevent hæmorrhage from the region where bone and dura meet round the inferior rim of the occipital bone defect by sewing the cut edge of the dura to the muscle at two or three places on either side It is wise not to open the cisterna magna widely unless it is needful to do so e g for a full inspection of the fourth ventricle or for splitting the vermis Puncture of the cistern with the pointed tenotome allows all the fluid to escape without having opened it up so fully that blood can enter the cerebro-spinal fluid spaces and cause a more stormy convalescence

The description which follows is of the exploration of the posterior fossa when it is certain that the lesion is not in the cerebello-pontine angle It is true that there may be doubts If so bone must be removed far laterally because the angle cannot be safely or adequately

explored through an exposure that would suffice for a mid line cer glioma The special approach to the angle so far as it c modifications is described on p 1457

Abnormal appearances.—The next step depends on the anat picture displayed. If a tumour can be seen altering the corte cerebellar lobe or even projecting through it the search is over as begun If not there may be local enlargement of cortical indicating the presence of an underlying angioblastoma wide the cerebellar folia of one side or of the vermis or again a tu tumour may extend from the fourth ventricle down over the surface of the medulla as happens with ependymomas. greyish opacities on the cerebellar cortex suggest secondary d from a medulloblastoma. If nothing so obvious is seen att is directed to the vermis Is it sunken? Is it hidden altog Is the volume of one cerebellar lobe clearly greater than the causing the vermis to be curved laterally? Further a very imp observation is made concerning the size and symmetry of the cer tonsils which are prolapsed when cerebellar tumours are p sometimes as low as the axis If one is unmistakably thicker and than the other there is certainly a tumour in the lobe of tha With a ventricular cannula gently and carefully inserted sea made for a definite resistance indicating the presence of a subc glioma or alternatively the wall of a cyst

If there is no abnormality save perhaps a slight generalized en ment of cerebellar mass and considerable tonsillar herniation should be done next? The first thing is to open the arachnoid cisterna magna by hooking it up and incising it with fine sc Cerebro-spinal fluid then escapes freely and the tonsils can b in detail If they show no pathological asymmetry they are carefully separated from one another with narrow brain retr and the foramen of Magendie sought Through this a good vie be obtained into the fourth ventricle and an ependymoma or c papilloma if present will be seen The ease with which the fo can be brought into view varies Usually the tonsils are stuck to the closed part of the medulla and gently laced there by fine noidal bands Gentle dissection will allow them to separate suffic for the calamus scriptorius and the posterior inferior cerebellar a to be well seen A fine catheter may be passed into the fourth ve and along the iter into the third ventricle. This ensures that is no gross block by tumour or verifies the presence of a strict the iter If no tumour has been discovered in the search out and usually it will have been found it is clear that the lesion is placed probably it is in the superior vermis This is espe *probable in children* who are so apt *to develop* medulloblas which invade any part of the vermis without its presence causi

of all gliomas and is well demarcated by appearance and texture from its surroundings (Fig 587) It may be vascular and very difficult to remove when large solid and high under the tentorium * The exact steps to be taken vary a little with every case and can only be learned by experience The cysts are the easiest Puncture alone is not enough the tumour causing the cyst must be found and removed Cerebellar cysts are never degenerative but are caused by active transudation alongside the growing point not into it Most deep tumours are best approached by splitting the vermis from below upwards after securing the surface vessels If even after puncture of the lateral lobes and splitting the vermis no tumour can be found the wound must be closed but the case kept under periodic observation with the intention of re-exploration should there be symptomatic recurrence.

Closure of the wound—When the operation is completed and every bleeding point has been secured the wound is closed by suturing the musculo-aponeurotic flap carefully back to the fringe of muscles below the superior nuchal line This is generally very easily done it is helped by slightly extending the head. The waxed silk sutures tied three times are placed 1 cm apart and when they are all in the surgeon should go over the line again looking for opportunities to place more. Whenever possible the dura should certainly be closed as well. Nothing has conduced to trouble-free convalescence as this most important action The scalp is closed in a further two layers as usual. The lateral ventricular cannula is taken out and the wound through which it was introduced closed Closure of the straight mid line incision is simplicity itself and is much speedier than the sewing up of the transverse incision. The fact that it is quicker and more bloodless to make and to shut are strong arguments in its favour Its disadvantage is that it does not suit the shape of all skulls and in some the exposure is not wide enough to permit successful search especially far out to the sides

As a final measure after the first dressings have been put on it is a help to carry a strip of elastoplast from the top of the shaven head to the back between the shoulders to relieve the muscles of the neck from strain

Cerebellar tumours are very interesting technical problems and on the whole they are quite as good risks as hemispheral growths although they ought to be much more formidable because of the proximity of the primitive vital centres in the brain stem Removal of the arch of the atlas greatly facilitates the recovery of medullary function and adds greatly to the patient s comfort during the immediate post-operative period.

After-care.—It is a good practice to leave the cerebellar case face downward on the shoulder rests until he begins to move This was

* Those who require further details of the technique of removal should consult Harvey Cushing' paper "The Cerebellar Astrocytomas, *Surg Gyn. Obst.* 1931 lii, 129

Cushing s practice Return to consciousness is usually very quick after the nitrous oxide is stopped. It is well to leave the intratracheal tube in place until the patient is definitely waking up he is then

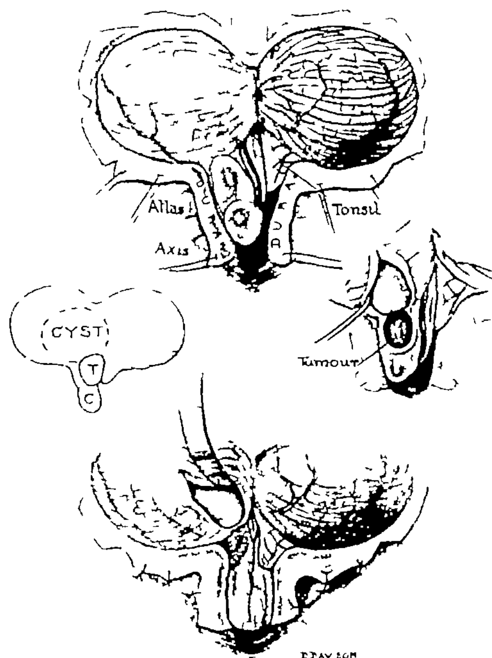


Fig 587 —Cystic astrocytoma involving cerebellar tonsil which is excised.

taken off the table and placed in bed with the head elevated. Car is taken with the first sips of water for he may have difficulty i swallowing though this is unlikely except with acoustic neurinomas

The only other special point is that lumbar puncture will probably be needed from the second day on The indications are pain in the back and limbs (indicating gravitation of blood down the theca) and pyrexia. I am no believer in routine daily lumbar punctures they are unnecessary and upset the patient But when headache is bad and there is considerable physical discomfort, punctures should be made and repeated as long as they are doing good service. Ventricular taps are rarely needed and usually are only done if a patient is sinking into coma or generally doing badly It needs some judgment to know when to perform the punctures but the rules are founded on knowledge of the physiological activities of the hypothalamus the brain stem the cerebro-spinal fluid and the effects that the tumour or its removal has had on them De Martel and Learmonth advocated drainage of the ventricles after operation by leaving a cannula in or by replacing it with a short length of sterile tubing led into a closed sterile receptacle sufficiently raised above the patient s head to keep the pressure in the ventricles about normal (i e. lying down at some 150 mm) I have found this helpful only when the tumour could not be removed

Variation in the cerebellar incision.—The exact relationship of the incision to the external occipital protuberance depends on the shape of the skull and the muscularity of the neck. It is not easy to expose the atlas properly if the incision is made well above the protuberance on a thick necked individual. To render this easier the incision is curved down at either side where the occipital artery may be met again as it emerges from its transit deep to the mastoid process. The straight vertical midline incision commends itself as an approach giving easy access to the vermis but it does not permit wide access to the sides I have often used it with the modification of undercutting the skin sufficiently to allow a short transverse division of the muscles on either side I have also used the alternative transverse incision 8 cm above the protuberance cutting the pericranium across sweeping it down and taking it and the muscles off the bone with the cutting endotherm in a continuous unbroken sheet (Peet) Closure is obtained by careful closure of the aponeurosis. The chief variations needed are for the acoustic neuromas and section of the fifth and eighth and ninth nerves in the posterior fossa (*q v*)

ACOUSTIC NEUROMAS

The problem of the acoustic neurinoma is different for here the approach must be a lateral one and it must secure free access to the posterior surface of one petrous bone. This can be achieved best by a vertical incision half way between the posterior border of the mastoid and the midline It runs from 5·0 cm above the superior curved line to a point well below it The aponeurosis and muscles are cut in the line of the incision and held apart with self retaining retractors In Fig 588 the unilateral hook-shaped incision still used

by some neuro-surgeons is shown A wide bone removal is now made the lateral sinus being exposed above The dura having been opened the cerebellum is gently retracted. The tumour or a cyst covering it, comes into view (Fig 588) it is embedded in the anterior surface of the cerebellum and is closely applied to the pons Varolii When a cyst is present the exposure is easier because once it has been tapped the cerebellum becomes more mobile and more of the tumour can be quickly seen The tumour is next uncapped by the removal of rather more than one-third of the lateral cerebellar lobe overlying it (*see* Fig 588) This is best done with a thin spatula after obliterating the vessels special care being taken to secure the veins on the superior surface Foam may be needed to stop bleeding from veins in the tentorium. By very cautious dissection with wet cotton pledgets combined with retraction of the cut cerebellar surface the lateral margin and posterior surface of the neurinoma are defined as far as is yet possible and vessels on its surface coagulated The veins give no trouble but the thin walled arteries may be recalcitrant and need patient handling

An incision is then made into the tumour and its interior gutted with a pituitary spoon Free bleeding follows and is arrested with cotton packs exenteration may take some time because it is unsafe to curette unless it can be done in a dry field This thoroughly done would terminate the original intracapsular operation of Cushing He preferred the subtotal method because the radical extirpation in vogue before his day carried a mortality of at least 70 per cent The difficulty is that some of these tumours are so fibrous that they cannot be broken up and eviscerated, while the removal of the centre from the soft variety does not always completely relieve the patient so stiff is the capsule that remains behind. Results are better if a more thorough extirpation is carried out

The alternatives that remain are (*a*) considerable removal of the capsule by punching it away with the pituitary rongeurs (*b*) the complete removal of what remains of the tumour after cutting its attachment to the internal auditory meatus. If complete extirpation is projected the tumour must be detached from the petrous bone at an early stage Although (*b*) is the ideal operation, the complete primary severance of the neurinoma from the porus internus requires the division except by the very skilled of the facial nerve as well as the auditory This is a disadvantage which a later facio-hypoglossal anastomosis does not completely remedy The gratitude of the patient for his cure may be tempered by annoyance at his disfigurement But if the neurinoma is to be totally excised (and I prefer it whenever it is feasible) the greatest care must be taken not to increase the injury which the tumour has already done to the brain stem and to avoid division of any vessels except those that can be seen to be entering the tumour itself. The correct procedure is to dissect the tumour away from its attachments from below not from its lateral margin

The vascularity of the neurinomas makes even the subtotal extirpation of the tumour a time-consuming affair. The chief vessels come (1) caudally from the vertebral or posterior inferior cerebellar arteries

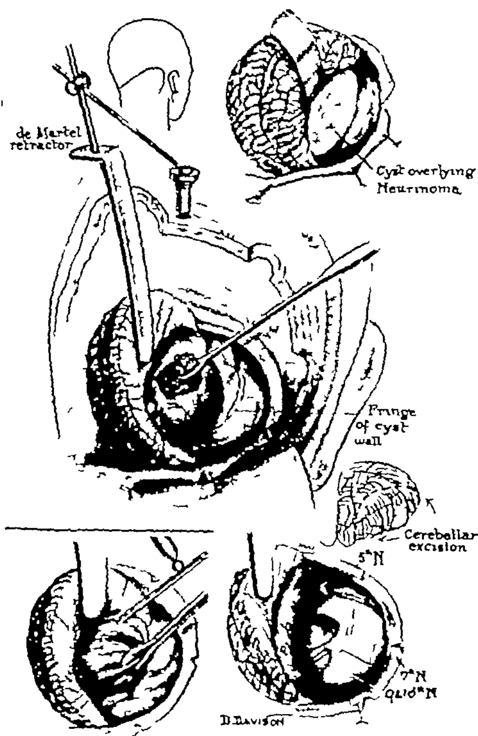


Fig. 588.—Stages in operation for acoustic neuroma. Average incision above. In centre de Martel flap has been cut.

(2) medially by short branches from the basilar and (3) rostrally from the superior cerebellar artery Bleeding is controlled chiefly by endotherm coagulation by covering bleeding points with cotton pledgets and working elsewhere until the hæmorrhage has stopped or by silver clips At an early stage of the operation care must be taken to identify and to protect the vagal group of nerves which are closely applied to the caudal pole The essentials of the operation are good access as free an exposure of the dorsal surface of the neurinoma as possible obtained by the repeated pulling of the capsule with the punch forceps laterally coagulation of its vessels after brushing the cerebellum away and the punching away of tumour tissue under vision as completely as is consistent with an undamaged brain-stem.

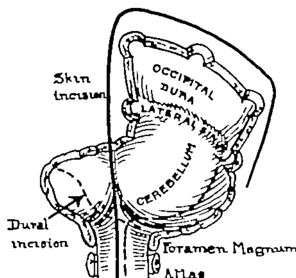


Fig 589.—De Martel's unilateral osteoplastic flap for cerebellar approach.

Difficulties.—The surgeon cannot know how complete a removal will be possible until the operation is actively in progress. The rare cystic variety is the easiest of all. In some neglected cases (the acoustic neurinomas are frequently not diagnosed as early as they should be) the tumour may be very large and intracranial pressure very high A wide decompression must then be made and the arch of the atlas removed. The de Martel incision (Fig 589) gives beautiful exposure and allows easy access both to the cerebello-pontine angle and to the tonsils The only thing against it is that the cutting of the flap takes so much time that it is a formidable operation in itself Technical difficulties arise from (1) extreme toughness (2) extreme softness (3) hæmorrhage (4) the protrusion in late cases of the superior pole of the tumour through the hiatus tentorii above and the pressure of its inferior pole into the foramen magnum below Toughness is a better 'fault' than softness whatever the consistence hæmorrhage is always free. What is more the substance of the soft neurinoma closely resembles brain tissue and the surgeon is faced with a dilemma Has sufficient tissue been removed and what risk if there in further deep curettage of perforating the capsule or of contusing the closely applied brain stem ? The only safe procedure is to do nothing except under such direct vision as can only be secured by the very free exposure of the tumour During radical extirpation the most dangerous steps are those necessary for the dissection of the

neurinoma from the brain stem but if the semi blunt pituitary punch is used the tumour finally tends to pull laterally so that access is at last obtained to the medial border there is then an opportunity for brushing the facial nerve off the deep surface and preserving it In that way practically the whole tumour can be removed Tissue in the porus itself must be curetted away separately

After-care

The post-operative treatment of these cases is as for cerebellar tumours with two additions (1) There may be difficulty in swallowing from mild trauma to the vagus The patient should be fed with a spoon but not before he has spoken the quality of the vagal voice can at once be detected. If there is dysphagia a Ryle s tube should be introduced and all feeding done through it Aspiration pneumonia (and cerebellar œdema) are the main causes of fatality (2) The other morbid condition to be guarded against is neuroparalytic keratitis which is a certainty if both the trigeminal root and the facial nerve have been damaged. Often there is some weakness of the facial musculature before operation a weakness that the manipulations may temporarily enhance with complete recovery later The eye should be protected with a Buller s shield or if the keratitis advances the lids must be sutured

Results

Cushing s mortality for intracapsular enucleation was 18 per cent. but in his last series of 50 cases there were only 2 deaths Olivecrona (1939) reported an 18 7 per cent. mortality for his series of 75 total extirpations the facial nerve had been preserved in 65 per cent but did not always function again. Olivecrona points out that the late results of the complete removals are greatly superior to those of intracapsular enucleation. Of Cushing s cases about one-third remained complete invalids and at least a quarter died from recurrence within five years We are doing better than that now (10 per cent mortality and rare recurrence)

TORKILDSEN'S OPERATION

A valuable method of overcoming blocks to the intra-cerebral cerebro-spinal fluid pathways was introduced by Torkildsen (Oslo) * It is naturally of most lasting use when the cause of the block is non malignant as in some strictures of the Sylvian aqueduct and in some cranio-pharyngiomas blocking the third ventricle. But it has a palliative value in the slowly growing diffuse gliomas of the basal ganglia which obstruct the egress of the cerebro-spinal fluid by reducing the third ventricle to a narrow slit The operation is quickly described. A narrow bore polythene or silicone tube is led out of

* Ventriculocisternostomy Arne Torkildsen. Oslo, 1947 "Aqueduct stenosis. Clinical aspects and results of treatment by ventriculocisternostomy (Torkildsen's operation). K. W. E. Paine and W. McKissock Jour Neurosurg. 1955, 12, 127

a lateral ventricle through a posterior burr hole a trifle lower than that advised for ventriculography but roughly in the same position This tube is then pushed down subcutaneously and brought out through a midline cerebellar incision The occipital squame is exposed and enough bone removed to give access to the cisterna magna into which the tube is tucked and there secured by a stitch often one

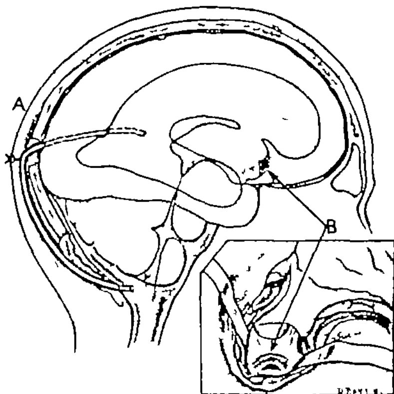


Fig 590 —Internal hydrocephalus due to stricture of the Iter of Sylvius. Re-establishment of C.S.F circulation by ventriculo-cisternostomy (A) Torkildsen's operation or by anterior third ventriculostomy (B)

in the dura is enough (Fig 590 A) A tube may be led out of each ventricle Cerebro-spinal fluid will continue to drain through the short-circuiting tubes for very long periods for years in fact The only rival to this operation is anterior ventriculostomy—the tearing of a hole into the lamina terminalis above the chiasma, exposed as for a pituitary tumour (Fig 590 B) It goes without saying that the third ventricle must be not only open but ballooned a state in which it finds itself only with posterior blocks e.g iter strictures and pineal tumours R T Johnson probably increased the value of this operation by pushing one end of a short fine silicone tube into the third ventricle thus opened and introducing the other end into the cisterna ambiens which encircles the mid brain This should lead the cerebro-spinal fluid back to a situation from which it is normally distributed in the subarachnoid spaces to be absorbed by the villi and capillaries

INTRAVENTRICULAR TUMOURS

It is not proposed to give any detailed account of intraventricular tumours which are not common Diagnosis can only be made by pneumography For those in the third ventricle which are chiefly paraphysial colloid cysts or cystic upward extensions of Rathke pouch tumours the approach is through the lateral ventricle opposite the foramen of Monro A small bone flap only is needed 4 0 cm front and back of the coronal suture and a cone of cortex removed

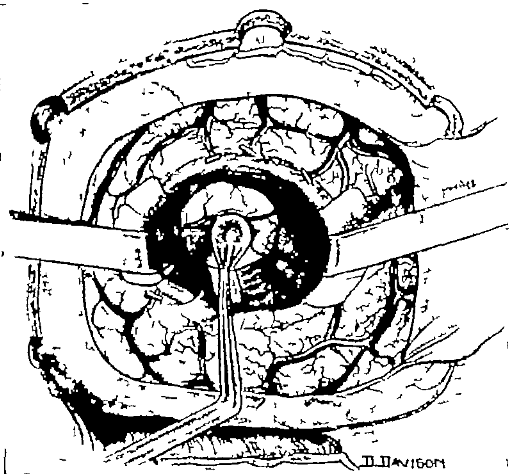


Fig 591 —Transventricular exposure of colloid cyst of third ventricle.

through the whole thickness of the brain until the ventricle is opened. A hole 4 0 cm in diameter allows full inspection and most tumours can easily be taken out through it (Fig 591) The foramen of Monro is generally seen at once but if not it can be identified by tracing the veins on the septum pellucidum down till they arrive at it Again the choroid plexus will be seen running backwards *from* it. The cyst can be dissected out of the third ventricle more readily if the anterior pillar of the fornix is cut through to enlarge the opening The cyst is seized pulled through into the lateral ventricle and removed after its vascular connections have been secured Tumours

of the lateral ventricles are rare they are usually meningiomas or circumscribed gliomas Removal of the former gives excellent results the prognosis of the gliomas depends on the extent to which the tumour is a local almost pedunculated product of the subependymal glia or is the sessile extension of a tumour in the basal ganglia or hemisphere.

Intraventricular operations are interesting interventions and not particularly difficult Rigid asepsis is necessary for infection of the ventricles may be only too easily induced by droplet infection from inquisitive and incautious onlookers

OPERATIONS ON THE PITUITARY GLAND

Four types of pituitary tumour may demand operation (1) the chromophobe adenoma (which is the most common) (2) the eosinophil adenoma of acromegaly (3) the rare basophilic adenoma (4) the congenital and usually suprasellar Rathke pouch tumour The last will be dealt with separately for its problem is a special one The indications for operation are two (1) failing vision due to chiasmal compression and more rarely (2) signs of endocrine dysfunction these disabilities may be present together As a generalisation, it can be said that operations on the pituitary gland are much more commonly undertaken because of visual failure than because of endocrine defects This is particularly the case with the chromophobe tumours where the body changes are often unobtrusive indeed visual defects are almost the only means by which they make their presence known. This is absolutely true of females past the menopause In younger ones amenorrhœa is the rule obesity may or may not be a feature. Headache is often slight with this kind of adenoma it is commoner in acromegaly for it seems to be more often due to progressive bone alterations than to distension of the pituitary capsule. Quite recently removal of the normal pituitary has been strongly advocated by H Olivecrona (Stockholm) for the relative control of secondary deposits from mammary and prostatic cancers—also to cure as far as may be the malignant diabetes of the young

Dyspituitarism may so adversely affect the patient s general health that the risk of operative intervention is increased. For example in acromegaly there may be glycosuria hyperthyroidism and hyperpiesis with chromophobe adenomas there is sometimes asthenia a lowered metabolic rate and hypopiesis. These changes stem from the atrophy of the endocrine glands which follows destruction or diminished activity of the master gland the pituitary The most dangerous consequences are those dependent on adrenal atrophy A small battery of tests can be applied to the hypopituitary patient in the search for Addisonian tendencies correctable by the pre and post operative use of suitable adrenal cortical extracts For the patient s future so much depends on the amount of active pituitary tissue

remaining on the periphery of the adenoma. This can only be estimated by laboratory tests though the physical condition gives clues An untreated case may do badly under the stress of operation but we have to recollect that Harvey Cushing's pioneer and very successful work on the pituitary tumours was carried out with no effective chemical endocrinal aids

In acromegaly the subject may go through a long life without his vision becoming affected only when the syndrome is clearly progressive is operation indicated. The rare basophilic adenoma (whose linkage with the clinical state of basophilism is admitted without complete certainty that it is the sole causal factor) calls for surgery on purely endocrine grounds In such a case operation would be limited to removal by suction of the adenoma thought to be accessible just beneath the diaphragma sellæ or to the implantation of radon seeds (A R D Pattison) a method which I know from experience to be quite useless for other types of pituitary adenomas Chiasmal compression has not been observed in any case of basophilism so far reported

With these indications clearly in mind the next point is to define exactly what the surgeon expects to do at operation No pituitary adenoma can be totally removed with a clearly defined capsule around it. The object of the operation is to free the chiasma from pressure by extirpating the contents of the tumour A remarkably clean removal can be achieved by the curette and suction if the tumour is attacked in the proper way First of all the approach must be decided upon. A much more complete removal can be made by the transfrontal operation than by the endonasal route. Indeed the latter is little more than a local decompression with incision of the capsule, though the surgeon may be tempted to do a lot more than this

Choice of Operation

The choice of operation lies between two classical operations the trans-sphenoidal and the transfrontal. Of the two the former obtained the earliest popularity at the hands of Harvey Cushing though in Europe the work of Hirsch of Vienna deserves mention To-day the transfrontal approach (which Sargent and Frazier always used and to which Cushing himself afterwards turned) is deservedly the more popular the trans-sphenoidal is reserved for special circumstances * The status of the two operations can best be gauged by stating their points for and against Cortisone should always be given to carry the patient over the acute stages at least

Transfrontal operation. *(a)* **Advantages.**—The lesion is much more easily seen and its nature identifiable. This route must be used if there is any doubt concerning the pathological nature of the agent causing the chiasmal compression e g a meningioma an aneurysm

* Sager (French) prefers the transethmoidal approach to the sphenoidal sinus and pituitary along the inner wall of the orbit (Chiari method) The distance is shorter and the exposure is said to be better but it is not

or even the dilated third ventricle (though there is little risk of this last mistake in competent hands for ventriculography excludes that possibility should clinical diagnostic means fail) Protrusions of tumour through the diaphragma can be fully dealt with and the commonly present sub-chiasmal nubbin pulled forwards from its hiding place (Fig 592)

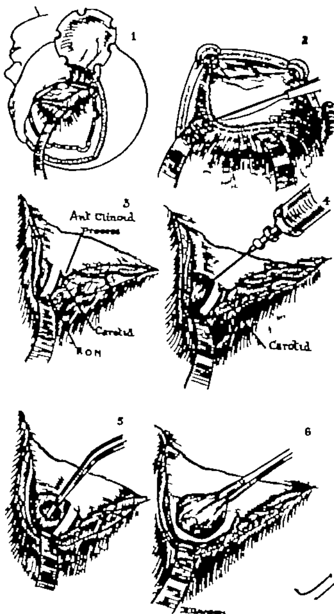


Fig 592 —Transfrontal approach to pituitary adenoma. Exposure, aspiration, suction of contents. Finally capsule pulled forward from beneath chiasma

(*b*) **Disadvantages** — There is no important disadvantage unless the chiasma is prefixed (as it is but rarely) Cushing suggested that bilateral central scotomata were indicative of pre-fixation and Henderson s and my own views confirm this In such cases the tumour compresses the macular fibres which decussate in the posterior edge of the chiasma. Given such fields the transfrontal operation is likely to fail

Technique of the transfrontal operation. —A general anæsthetic is usually employed The patient lies supine with the base-line perpendicular to the floor After the usual preliminaries either a Trotter or a Souttar incision is made I prefer the former There has been some difference in practice between different surgeons as to which side should be opened It has been held that it is better to expose the side of better vision so that the better optic nerve can be seen and protected Equally it has been held that the side of worse vision should be entered in case the patient has a pre-fixed chiasma (5 per cent of normal individuals) In this state the optic chiasma

may cover the front of the tumour so completely that it leaves the surgeon no room to reach the adenoma except by cutting an optic nerve or by splitting the chiasma vertically Such a step is very rarely necessary and although I have done it I think I could have avoided it It is very difficult to say when an optic nerve is irretrievably atrophied Henderson has referred to one case of Cushing s in which the pre-operatively blind eye was eventually the only seeing eye An experience such as that makes one very chary of sacrificing an optic nerve since one cannot be sure that it might not finally be the better one. On the whole the surgeon who goes always from the right side irrespective of vision will find that he does very well

A large bone flap is unnecessary The skin flap is dissected down to a point a centimetre above the supra-orbital ridges The bone flap is cut and turned down in the usual manner There is no need to transgress the midline but in this anterior third of its course the sagittal sinus could be uncovered without much bleeding The chief anxiety lies in the point of section anteriorly i e above the orbit The antero-posterior radiographs must be carefully studied to determine the size of the frontal air sinus An idea of its extent can be formed and will be confirmed by careful inspection of the skull. The sinuses nearly always make a faint bulge and the lowest drill hole must be sunk a few millimetres above this point If they do not show any surface evidence great caution must be used in placing the burr hole Even if the sinus is avoided with the drill there is still a risk of opening it with the Gigli saw if the sinus has much of an extension laterally None the less the operator requires this supra-orbital incision to be as low as possible because he wishes to approach along the floor of the anterior fossa without a high ridge of bone to impede his view The bone flap having been reflected hinged on the temporal muscle wet cotton or lintine must be placed over the lacunæ along the sagittal sinus to check bleeding This having been stilled and perhaps a hitch-stitch or two placed in position the operation is proceeded with (The gloves may be changed with advantage at this point) The best exposure is obtained by the intradural route but there is then more risk of damage to the brain by retractors of snapping of veins entering the venous sinuses and of post-operative œdema

The better if a slightly more difficult route is the extradural The frontal lobe is elevated from the roof of the orbit by dissection with wet cotton pledgets or dental swabs the dural-covered brain being gently held up with a brain retractor The dura peels off the roof of the orbit very easily once a start is made It is best to begin on the outer side A good headlight and illuminated retractors are needed as the lesser sphenoidal wing is approached and the dura can no longer be separated The elevation must be carried medially to the base of the anterior clinoid process The whole of the orbital plate of the frontal bone is now clearly visible one or two small issuing vessels may have to be plugged with Horsley s wax. The dura is then put on the stretch and divided horizontally 8 mm above its attachmen

to the sphenoidal wing (Fig 593) This must be very cautiously done the incision is not carried to the extreme lateral limit for fear of injuring the middle cerebral vein As soon as the dura is opened there will be a free escape of cerebro-spinal fluid which makes the rest of the exposure much easier Very narrow wet strips of lintine are inserted under the dura still to be cut and pushed along a little in advance of the scissors The cut in the dura is thus carried

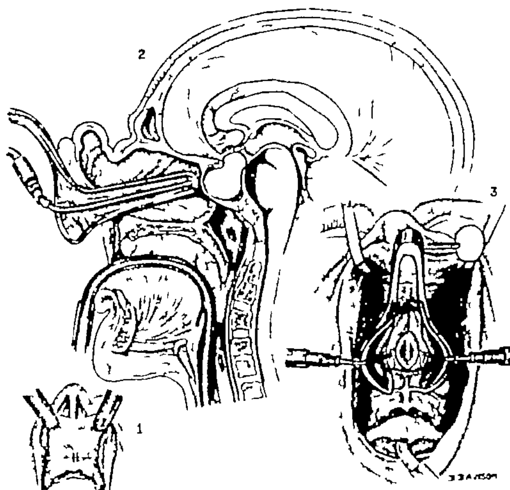


Fig 593.—Trans-sphenoidal approach to a pituitary adenoma.

towards the midline till it can get no further and then comes forward to the crista galli. The illuminated retractor is insinuated under the brain through the dural opening after protection with lintine strips

In the rarer cases where the tumour is very massive the brain cannot be sufficiently retracted to allow of good enough exposure. A ventricular tap helps a little and in extreme instances part of the right frontal lobe can be resected but I have only twice had to do that and then with complete success I should prefer to break off the operation and proceed under local anaesthesia another day but in one

of the cases referred to this had already been done Ordinarily the right optic nerve comes easily into view just to the left of the anterior clinoid process and to its inside the pituitary adenoma will be glimpsed The exposure is improved gradually by shifting the retractor deeper towards the midline The olfactory tract is seen and elevated with the brain Often it pulls off and an unavoidable unilateral anosmia follows but it is of no great moment The tumour and optic nerve are covered with a veil of arachnoid which must be torn through most carefully with a small rectangular hook. All these steps of the operation demand the utmost gentleness and sureness of hand The ease of approach to the adenoma itself depends on the fixation of the chiasma. If it is prefixed (5 per cent of individuals) the adenoma lies behind it and there may be the merest slit below it insufficient to allow surgical manœuvres The alternatives then are (*a*) to make a small vertical incision in the chiasma at its thinnest point through which to suck the adenoma away (*b*) to divide the optic nerve (*c*) to close the wound and re-operate by the trans-sphenoidal route The choice will depend on the visual fields the visual acuity in the nearest optic nerve usually the right and on the local condition under inspection With normal and with post fixation all that is necessary to expose the tumour is to dissect the arachnoid off the right optic nerve and the tumour until a length rather more than 2 cm is in view It is wrong to insist on the display of the chiasma in every case regardless of the size of the tumour and the accessibility of the chiasma If the retraction is carried too far post-operative hypothalamic disturbances are much more likely and may cause a fatality in an operation that has gone very well and does not merit such a result Sometimes adenomatous tissue tracks under the nerve elevating it to appear on its outer side bulging against the artery Vision will not be restored unless such a protrusion is dealt with but first the main adenoma must be exenterated. The surgeon unless very expert deals very circumspectly with tumour nubbins on the outer side of the optic nerve for fear of injury to the carotid artery When the tumour has been exposed to the inner side of the optic nerve a vessel or so usually of small size will be seen coursing over its capsule These may be coagulated with the diathermy but great care must be taken not to transmit the heat to the optic nerve.

The capsule of the adenoma (the stretched diaphragma sellæ) is incised with a narrow bladed knife after aspiration has ensured that the tumour is not an aneurysm Soft tumour tissue usually escapes at once With a blunt Cushing pituitary spoon some of the contents are carefully removed for microscopy and the sucker nozzle inserted. It is possible thus to remove the whole contents of the fossa very easily and expeditiously The only difficult place is under the right optic nerve but a special nozzle with a lateral bend at its tip (Olivecrona) makes the removal of tumour tissue from that situation more easy Often the interior of the sella is now felt and even seen to be quite smooth all tumour tissue having gone The capsule usually collapses

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and can be coaxed into the bottom of the sella It should be seized with fine angled forceps and drawn forwards from beneath the chiasma by so doing an appreciable nubbin of tumour can often be pulled out from there or from beneath the optic nerves and removed. Some of the capsule may be cut away as a last step but this depends on the size of the tumour and on the ease of doing it If it looks very difficult it will not be safe.

The harder tumours are much more difficult and for some a sharp spoon or punch forceps will have to be employed Unless these are used with great caution the optic apparatus may be damaged. The pituitary is a vascular gland and usually considerable bleeding attends the removal even of the softest tumours. The vessels are the short fine tributaries to the anterior lobe (pars buccalis) from the internal carotid artery in its intracavernous course. Fibrin foam should be inserted in the shell of the tumour and covered with lintine whilst the sucker keeps the field dry It is understood that all this time the optic nerves are most carefully avoided. It may be necessary to wait some time before all bleeding is arrested—from 10 to even 30 minutes The wound must not be closed until the bleeding has definitely stopped and washings come back clear after removal of the fragment of foam It is a good plan to save the bone dust from the burr holes during entry and replace it in those of the midline where lie the two holes which are most likely to leave unsightly depressions

Difficulties. 1 Opening the frontal sinus.—Unless the mucosa is actually torn there is little risk of infection. I have exposed the mucosa a few times and once or twice inadvertently opened it but without mishap My practice is to place a small piece of beaten muscle over the mucosa and then wax it over It is not good to plug wax freely into the sinus as it seems to me that wax may cause trouble rather than prevent it At the close a piece of pericranium is cut and laid over the site of the injury to the sinus The bone flap fits back so accurately that this little graft is jammed and cannot slip away Such manœuvres have so far invariably proved successful. If the sinus were infected at the time of operation it would of course be impossible to proceed further Study of the X rays beforehand gives information on that point.

2. A greatly adherent dura.—This can be a difficulty with all bone flaps but especially in old people When the bone is being broken back the surgeon can at once feel whether the dura is adherent and can separate it by blunt dissection. Tears in the dura do not matter much the danger is that the cortex may be injured and hæmorrhage occur The only dangerous place is along the sagittal sinus and just beside it where the parasagittal veins could be pulled off If that happens the lateral ends are coagulated and the points of entry into the sinus covered most carefully with adequate muscle grafts

3 Imperfect exposure of the tumour —Pituitary tumours develop from beneath the chiasma and present anteriorly to it but the rare

pre-fixed chiasma makes difficulties whatever the skill of the operator Some pituitary tumours are very florid forming large extensions which add greatly to the difficulties and dangers of the operation

Complications.—The commonest is post-operative clot (p 1439) Apart from this the only important ones are the tuberal (hypothalamic) crises or disturbances that only occasionally mar the smoothness of recovery At their worst they will cause a fatality whatever is done The patient then never fully regains consciousness the temperature steadily rises to 107° or over there is no sweating but the face is flushed and the pulse and respirations become very rapid. In the milder cases cold sponging or wrapping in a wet sheet and especially rectal irrigation with ice-water powdered aspirin by mouth and pituitrin hypodermically will combine to bring the temperature down and tide the patient over Measures must be instituted if the temperature exceeds 103° when all covering except a sheet is removed from the bed. They will be increasingly energetic if the pyrexia proves difficult to control. Polyuria and polydipsia may also cause discomfort but can be effectively countered by the hypodermic administration of pitressin tannate

Nowadays pituitary operations are always carried out under cover of cortisone (100 mgms) for 3 or 4 days commencing the day before and tailing off to smaller doses for long periods Cortisone has not proved a cure all for all post-operative troubles

If all has gone well the sutures are removed on the third day and the patient allowed out of bed before the week is over The scar is negligible if the skin is carefully sutured in layers and especially if the frontal limb of the incision is made dead in the centre of the forehead.

Results.—The results of the transfrontal operation are very good The mortality is little if anything higher than the trans-sphenoidal at the present day 4 to 5 per cent * I had a run of 87 with no deaths and then lost an old man with a very advanced tumour which ought to have been left alone Indeed most fatalities occur in the neglected cases where the cause of the visual loss has not been appreciated until too late—an occurrence all too common It is very difficult indeed to know with certainty when a pituitary tumour is definitely inoperable pneumography is a great help for it demonstrates the size of the tumour It is often in the worst cases that the greatest pressure is put on the surgeon either by medical colleagues or by the sufferer himself The causes of mortality are post-operative clots (early recognition will often avert disaster) an uncontrollable hypothalamic crisis or an Addisonian crisis due to adrenal atrophy precipitated by the stress of operation The immediate improvement of vision is much greater by the transfrontal than by the transnasal operation unless the tumour is cystic when the effects are equal Little improvement

* The mortality is highest (maybe 20 per cent.) in cases with extensions of adenomatous tissue into the hypothalamic, temporal, or frontal regions It is lowest (about 2 per cent.) with the commoner small chromophobe adenomas with chiasmal field defects and no headache

will result when the tumour has compressed the optic nerves for so long that atrophy has occurred. Some very pale nerves are anæmic rather than degenerated but the length of history will usually give a very good indication of what can be hoped for in the way of recovery Even in these bad cases tumour removal may help to delay complete blindness Deep X ray therapy is instituted post-operatively in all cases It is not a good primary method of dealing with pituitary adenomas except the acromegalic without visual loss because it may cause an acute swelling of the tumour and sometimes a late death from necrosis of the brain a thing that I have known happen twice.

Trans-sphenoidal approach. (*a*) **Advantages.**—(1) The operation upsets the patient very little—scarcely more than an ordinary removal of the nasal septum For that reason it is suitable for aged patients or those whose general condition does not recommend them for a severe operation This is especially true of those with a high blood-pressure or cardio-renal damage those who might more readily develop post-operative clots or become mentally upset after the frontal operation (2) It is useful also in those neglected cases where very large tumours have been allowed to develop These are always very formidable problems and probably are better left alone especially if the patient is nearly blind. Some are worth a trans-sphenoidal decompression as they may if they are lucky preserve their sight or even find it improved after what must always be a relatively inadequate operation. Some of the factors mentioned above enter into the question of the acromegalic cases with, now an addition (3) these patients are well known to possess very large frontal sinuses which may require the surgeon to cut the flap very high anteriorly and this makes a transfrontal approach much more difficult. (4) Bilateral central scotomas suggest prefixation of the chiasma with the tumour largely hidden behind it In such case the tumour can be more adequately dealt with by the trans-sphenoidal than by the transfrontal route

(*b*) **Disadvantages.**—The two chief disadvantages must be mentioned first (1) a cramped and inadequate exposure (2) the risk of sepsis and meningitis In actual practice if the right case is chosen the view obtained of the adenoma by the inferior approach is better than would be imagined. But it needs a case in which the floor of the sella has been greatly depressed, until the sphenoidal air sinus is obliterated. In such circumstances the tumour seems to rest on the vomer and when the wide flange of its base is removed the tumour is at once seen and can be exposed for at least 2 by 1 5 cm. The capsule was originally only incised and nothing more done than this pure decompression. Of more recent years removal of tumour contents has become more radical, but one cannot say exactly how much can be taken out with impunity from any given case. The best cases are those with cystic or very diffluent contents A very hard tumour which does not sprout downwards at all when the capsule is

incised will probably not derive any benefit Unfortunately this cannot be determined beforehand When the sphenoidal air sinus as demonstrated in the lateral X ray is very large the operation is more difficult

The incidence of sepsis in Cushing s series of 167 cases was 2 per cent. The risk is both immediate and late for a patient may develop a pituitaritis and succumb to basal meningitis some weeks or months after what has had all the appearances of a very successful inter vention There may be other difficulties as well the thick heavy and vascular bones of the acromegalic make the operation difficult And this intervention is absolutely contra indicated if there is the slightest doubt of the nature of the lesion causing the visual upset for no other than a pituitary adenoma can be attacked by this route. Because nasal infection vetoes this approach a post nasal swab should always be taken On the whole the disadvantages seem so over whelming that it might be set aside as an operation which has played an important part in the evolution of the surgery of the pituitary but is now obsolete. But there is no doubt that it can occasionally be usefully applied to the carefully selected case

Technique of the trans-sphenoidal operation.—The steps in this operation can be seen in Fig 593 The operation is best done in a darkened theatre The nose is packed an hour beforehand with a 10 per cent. solution of cocaine and adrenalin When endotracheal anæsthesia is going smoothly the pharynx is packed with sterile gauze to prevent blood trickling down The technical steps are those of the submucous resection of the nasal septum with some important differences. First the septal separation is carried out after an incision has been made in the superior gingivolabial groove. This is carried to the bone and by dissection from the base of the alveolar process upwards the floor of the nose is reached on both sides The maxillary spine is chiselled off and the mucosa lifted from the floor of the nose and off the sides of the nasal septum in the usual way care being taken not to button hole the muco-perichondrial flaps This was Cushing s route but the operation can be done by the classical nasal method of submucous resection The septal separation and removal is carried out far back indeed to the posterior end of the vomer a nasal speculum with long narrow blades being a necessity The second variant from the more usual septal operation is that the submucous dissection is carried up along the vomer to the roof of the naso-pharynx and on to the rostrum of the sphenoid At this point or before it Cushing s special strong speculum which is better if it carries its own illumination is inserted and the blades separated as far as possible If the nose is exceptionally narrow more room can be obtained by the use of dilators the larger sizes of Hagar s being useful though Cushing had some short straight ones made. It is bad practice to remove the middle or inferior turbinates as this must lead to nasal sepsis afterwards and that at a time

incised will probably not derive any benefit Unfortunately this cannot be determined beforehand When the sphenoidal air sinus as demonstrated in the lateral X ray is very large the operation is more difficult

The incidence of sepsis in Cushing s series of 167 cases was 2 per cent The risk is both immediate and late for a patient may develop a pituitaritis and succumb to basal meningitis some weeks or months after what has had all the appearances of a very successful inter vention There may be other difficulties as well the thick heavy and vascular bones of the acromegalic make the operation difficult And this intervention is absolutely contra indicated if there is the slightest doubt of the nature of the lesion causing the visual upset for no other than a pituitary adenoma can be attacked by this route. Because nasal infection vetoes this approach a post nasal swab should always be taken On the whole the disadvantages seem so overwhelming that it might be set aside as an operation which has played an important part in the evolution of the surgery of the pituitary but is now obsolete But there is no doubt that it can occasionally be usefully applied to the carefully selected case

Technique of the trans-sphenoidal operation —The steps in this operation can be seen in Fig 593 The operation is best done in a darkened theatre The nose is packed an hour beforehand with a 10 per cent solution of cocaine and adrenalin When endotracheal anæsthesia is going smoothly the pharynx is packed with sterile gauze to prevent blood trickling down The technical steps are those of the submucous resection of the nasal septum with some important differences First the septal separation is carried out after an incision has been made in the superior gingivolabial groove This is carried to the bone and by dissection from the base of the alveolar process upwards the floor of the nose is reached on both sides The maxillary spine is chiselled off and the mucosa lifted from the floor of the nose and off the sides of the nasal septum in the usual way care being taken not to button hole the muco-perichondrial flaps This was Cushing s route but the operation can be done by the classical nasal method of submucous resection The septal separation and removal is carried out far back indeed to the posterior end of the vomer a nasal speculum with long narrow blades being a necessity The second variant from the more usual septal operation is that the submucous dissection is carried up along the vomer to the roof of the naso pharnyx and on to the rostrum of the sphenoid At this point or before it Cushing s special strong speculum which is better if it carries its own illumination is inserted and the blades separated as far as possible If the nose is exceptionally narrow more room can be obtained by the use of dilators the larger sizes of Hagar s being useful though Cushing had some short straight ones made. It is bad practice to remove the middle or inferior turbinates as this must lead to nasal sepsis afterwards and that at a time

when it is important that nothing of the kind should occur The shrinkage brought about by the pre-operative use of the cocaine-adrenalin pack is sufficient.

Sometimes the capsule of the tumour comes into view as soon as the alæ of the vomer are taken out at other times the anterior wall of the sphenoidal air sinus must be punched away with suitable long handled forceps The capsule ought to be visible for a good 1 5 cm. before it is incised. When this is done the tumour tissue extrudes itself and at this point the original Cushing operation stopped. There is no doubt that the removal of the vomer allows the tumour to descend and to decompress the optic nerves by sinking lower into the roof of the naso-pharynx. The vomer is a strong bone and acts as a prop between the sphenoid and the hard palate In my view it is the removal of the vomer rather than the opening into the sphenoid which is the most important step when the tumour is large.

The more adventurous will not be content with decompression alone but may insert a curette or the suction nozzle and remove a considerable quantity of tumour In its ideal state—when no holes have been made in the mucosa of the nasal septum or in its reflected part where it becomes continuous with the roof of the naso-pharynx—there should be very little risk of infection It should therefore be safe to do something more than merely incise the capsule of the tumour but not if the septal dissection has gone badly Philips recommended that the capsule of the tumour should be grasped in punch forceps and pulled down until cerebro-spinal fluid escapes. The sphenoidal air sinus should have been practically obliterated by the descent of the tumour otherwise the case has been badly chosen. The operation is completed by the withdrawal of the speculum and the insertion in each nostril of sterile lubricated finger-stalls packed with gauze.

Hypophyseal Duct or Pituitary Anlage Tumours

These tumours exist in two forms pre- and post-chiasmal. The former are largely intrasellar producing symptoms and signs similar to those of a pituitary adenoma the only difference being as a rule the youth of the patient or his infantile state and the presence of intra or local supra-sellar calcification as proved by X rays

Pre-chiasmal.—This variety is dealt with by the transfrontal pituitary approach just described. The tumour can usually be completely removed once it has been freed by careful dissection from the chiasma and carotid arteries The capsule is tough enough to be dragged out completely though sometimes an optic nerve must be cut. This is a more justifiable procedure in the dislodgement of one of these anlage tumours than with an adenoma.

Post-chiasmal.—In the second type the tumour rises above the sella largely behind the chiasma and produces homonymous rather than

bitemporal field defects It is usually capped by a cyst which may extend high into the third ventricle and lead to obstructive hydrocephalus with papillœdema instead of the optic atrophy which is the sign of pre-chiasmal lesions It should be stated at once however that the surgeon cannot accept all these tumours for operation If they are heavily calcified they are usually solid cement like brittle adamantinomas and should be left alone The less calcification the better for that indicates a cyst which may rise high into the third ventricle The approach to these cysts is through the lateral ventricle which is always dilated. A brief description of the approach is given under Intraventricular Tumours (p 1463) The results of operation are good for the pre-chiasmal intrasellar kind but variable to bad for the commoner second type depending on the extent of the tumour conglomerate Some have all the histological appearances of basal celled carcinomas The surgical mortality of these tumours some 40 per cent. is the highest in brain surgery Most of us prefer to treat the more formidable examples now by short-circuiting the cerebro-spinal fluid from the lateral ventricles into the posterior fossa (*see* Torkildsen s operation p 1461) leaving the tumour untouched This may succeed very well because symptoms are often due to subacute hydrocephalus but it is too complicated a story for full length discussion here

Suprasellar Meningiomas

These tumours whose recognition as a definite group we owe to Holmes and Sargent and to Harvey Cushing produce the same visual changes as pituitary adenomas without the sellar changes They spring from the tuberculum sellæ and compress the chiasma from before backwards The approach to them is the same as to the adenoma, except that it is best done intradurally The operation is undertaken on the side of better vision as the opposite optic nerve is much more difficult to see than in pituitary adenomas and is therefore in danger These tumours are always very difficult surgically and may appear impossible but if they are dealt with carefully and methodically they are usually removable The meningioma usually has to be reduced considerably in size before mobilization because its attachment cannot at first be clearly seen Vessels on the surface are coagulated and portions of the tumour punched away with the pituitary punch forceps or looped with the cutting current so as to reduce bulk. Next the attachment to the tuberculum sellæ and pituitary diaphragm is sought and little by little cut through with the hook and endotherm applied to its handle when freed in this way the tumour can be withdrawn. During the extraction of this residual portion it is important to free it from the optic nerves and chiasma by very gentle blunt dissection The area of origin from the dura is heavily coagulated at the close to kill remaining tumour cells and arrest oozing from perforating nutrient vessels

THE SURGERY OF TRIGEMINAL NEURALGIA

The operation of choice for true paroxysmal neuralgia is division of the sensory root of the Gasserian ganglion This the Spiller Frazier operation has entirely superseded the excision of the ganglion of earlier days though the modern operation has evolved from it Operation and alcohol injection are not really rival methods but rather alternatives and each has its place Both demand a high degree of skill The modern operation embodies two refinements that ganglionectomy did not have sparing the motor root and fractional section of the sensory fibres i.e. cutting only such rootlets as are concerned in the conduction of the painful impulses in each particular case This depends on the fact that the fibres entering the ganglion from the periphery pass backwards from cell stations through into the sensory root in much the same order from above downwards as they entered it. The ophthalmic fibres are uppermost the mandibular fibres lowermost in the root as well as in the periphery and in the ganglion This anatomical plan is not absolutely rigid and as the root passes backwards a certain amount of interchange and rotation takes place None the less great use can be made of this arrangement for it is possible to spare with considerable accuracy the fibres destined for the eye thus reducing to a minimum the risks of neuro-paralytic keratitis When alcohol is injected into the ganglion its diffusion cannot be controlled sufficiently to allow the fractional destruction of cells and fibres and though patchy anæsthesia often follows the use of small quantities *its distribution* cannot be well enough ordered to make it a method of precision The advantage of operation becomes clear only thus can one make a selective and managed de-afferentation of the face

The common practice amongst neuro-surgeons to-day is to perform fractional root sections for patients with tic limited to one or two divisions (usually the second or third) and to inject the ganglion in the rarer cases where all three are affected

Section of the Sensory Root of Trigeminus

The operation is always carried out with the patient seated in a dental chair which may be equipped with a special head rest. The advantages of this position are many for one thing bleeding is minimized for another anatomical relationships are invariably memorized as if the subject were in the erect posture and it is most important that they should be very clearly in mind during the stages of exposure of the sensory root. The only possible disadvantage is that of anæsthesia. The operation can be done under any anæsthetic the best *is local assisted by intravenous pentothal or chemithal*. A drop in blood pressure accentuated by the erect posture may cause anxiety though I have never known any actual harm from it. Individuals vary a good deal in their susceptibility so that it is well to be able to lower the head if there should be too alarming a fall in

pressure The patient s eyes are covered as soon as he is anæsthetized with sterilized rubber tissue to prevent damage to the cornea. If one side only of the head is shaved there are never last moment doubts as to which is the affected side The patient is seated in the chair a long sheet is carried round the knees making its chief pressure at the level of the tibial tuberosities and fastened to the chair behind to prevent slipping The head rest is adjusted to the neck so that the mastoids rest against the pads and the head is fastened by a strip of elastoplast on the side away from the operation It is important that the head should be fixed so that the face looks directly forwards and is not tilted up towards the ceiling The incision is marked out with iodine before any drapes are applied (this is important) and then scratched in A piece of cotton wetted with alcohol is placed in the external auditory meatus

Technique.—The incision is shaped like a hockey-stick (*see* Fig 594) curving backwards above the vertical limb is 2¼ in and the turn backwards about an inch long It should be placed immediately behind the half way mark between the external auditory meatus and the external angular process If it is farther back than that the foramen spinosum seems always to be very far forward and consequently the middle meningeal artery is more difficult to secure The incision just reaches the upper edge of the zygoma, but no more or seventh nerve fibres to the muscles of the forehead will be cut Note must be taken of their probable course in marking out the skin incision and it may be well to curve the lower centimetre of the incision obliquely backwards to avoid them (as in Fig 591) Patients heads vary and incisions must be made to suit them The incision is marked out with iodine after which novocain adrenalin is infiltrated. A 10-in square of lint wrung out of perchloride solution (1–1 000) is next sutured to the skin to exclude the pinna. After placing the wet towels carefully and fixing them in position the whole patient and chair are draped. A high instrument tray is placed alongside the patient s head on the opposite side level with the vertex and the drapes are thrown over that In this way the patient s head is enclosed in a small tent to which the anæsthetist has access to keep track of blood pressure respirations and so forth The tray is very useful as a resting place at a conveniently high level for instruments

The lint is cut with scissors over the line of the skin incision which is carried down to the temporal fascia in the usual way Artery forceps on the edges of the incision are a nuisance and are better replaced by Michel clips compressing the cut edges 1 cm apart A large branch of the temporal artery is caught and tied at once with fine black iron-dyed silk The scalp is next freed from the temporal fascia by sharp and blunt gauze dissection until a flap of temporal fascia can be cut and dissected off the muscle This can be very neatly done with the diathermy needle The temporal muscle is split with the same instrument from top to bottom of the wound and a self

retaining retractor inserted. The temporal muscle is separated from the bone and pushed forwards and backwards care being taken not to pull it off its superior attachments If it is so thick that it interferes with the proper exposure of the bone it may have to be divided below in a forward direction for a centimetre The bone must be cleared downwards to the inferior temporal crest that is deep to the zygoma, especially anteriorly An area of bone some 4 cm. in diameter having been bared and the self retaining retractor re-adjusted, the bone is drilled and removed after careful separation of the dura. This is often very easily done it if should be difficult the separation must be made with the utmost care and patience no corner-cutting is permissible here This is particularly true of the point where the dura lining the lateral wall of the skull changes over to that of the base. By keeping the tip of a curved dissector such as Adson s closely pressed against the bone the dura can eventually be coaxed away Any sign of shredding of the dura is a challenge to technique which patience will overcome. The bone removal must be carried very low down because entrance is effected along the floor of the middle fossa. The dura is now stripped off the base this is much easier than the separation from the lateral wall and once it has started to come up it continues to do so readily under the pressure of a small moist dental swab These swabs are great helps in the dissection of the sensory root and should have long coloured strings so that they do not get overlooked when left in place for the temporary arrest of hæmorrhage An electrically lit retractor is inserted now or even earlier to hold up the temporal lobe

The next objective is the middle meningeal artery It may have already caused some bleeding especially if the bone removal has been carried far upwards and forwards It is easily controlled by electro-coagulation or by wax if its tunnel in the bone at the pterion is broken into The groove in the floor of the middle fossa leads eventually to the foramen spinosum and thus forms a guide. Here the emergent artery is dissected free and the foramen plugged with a small piece of boiled tapered match-stick these sticks should be prepared beforehand. Alternatively the small square-ended hook is pushed into the foramen and the handle touched with the diathermy The direction in which the artery traverses the bone is not constant but is always quite easy to discover The artery is cut through in the foramen with a sharp-pointed tenotome the tip of the knife within its rim There is rarely any bleeding from the upper end if there is it is at once stopped by the electric current The middle meningeal vein does not accompany the artery through the foramen spinosum it leaves through the foramen ovale Unless it is coagulated as it lies in the dura deep in the middle fossa it will bleed when the dura is disturbed in the next move

Just in front of and deeper than the foramen spinosum is the foramen ovale This foramen is filled by the third division which cannot be seen until the dura is stripped from it It is important that the third

division should be approached slightly from the front The worst thing that can be done is to come on it too far back for blunt dissection then will almost certainly drag on the petrosal nerve and facial paralysis will result Moreover the ganglion may be lifted up in its sheath a thoroughly bad thing By blunt dissection the dura covering the division is swept upwards and backwards from the anterior margin of the foramen ovale (At this point venous bleeding may be encountered if the meningeal vein has not been dealt with) Often the dura slides up at once but if it adheres light touches with the knife free it and the fibres of the third division can then be identified The dura is then pushed up again but it will soon stick and a new incision is made to start it off once more A metal blunt dissector may be used cautiously to help the elevation of the dura from the mandibular division once the nerve fibres have been seen Touches with the knife blade are very important and the most difficult point in the craft of this operation is to know just when and where to make them In general they are made over the front and along the outer side of the third division and the ganglion but they must not be deep enough to cut the nerve The dura also needs elevation from the petrous bone on the outer side of the third division Hence the light cuts with the narrow bladed knife must be prolonged externally along the petrous bone If the dura at this point is separated by forceful pushes with a wet dental swab the great superficial petrosal nerve is almost certain to be badly pulled facial paralysis results By sharp dissection it is possible to leave the petrosal nerve undisturbed on the petrous bone with a thin layer of dura attached to it there is a natural line of cleavage there between two layers of dura. The petrous bone is bared again above this point up to the superior petrosal sinus Sharp dissection will be necessary in front over the whole width of the third division medially as well as on the outer side if a proper exposure of the ganglion and root is to be effected The division in its intracranial course is flat with its anterior surface facing outwards and forwards so that its borders are antero-medial and postero-lateral. (Fig 594) Some bleeding from a vein leading into the cavernous sinus may be started but is easily stopped by a muscle graft The arachnoid-covered root is finally bared the membrane is commonly so opaque that the actual fibres cannot be seen through it As a general rule it can be said that in order to expose it at least 2 5 cm of nerve must be laid bare above the foramen ovale

It is recognized by two things firstly the cerebro-spinal fluid layer surrounding it makes it appear slightly darker than the compact third division itself secondly the pulsation of the fluid can be recognized. As soon as the root is uncovered the arachnoid is incised cerebro-spinal fluid escapes and is sucked away The sucker and the illuminated retractor together make this operation a comfortable one. The higher the root has been dissected up towards the top of the petrous bone the easier it is to pick up its individual fibres The knife must not be used to cut through the root because the carotid artery

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in its canal in the petrous bone is not always fully roofed Such fibres of the root as are to be divided are picked up with a fine hook and torn or cut through with Adson s guillotine. There is rarely any bleeding

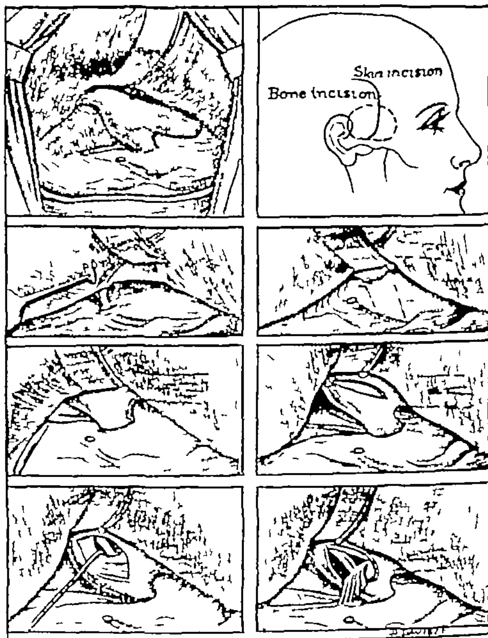


Fig 594.—Fractional division of sensory trigeminal root, sparing motor root. Stages in the exposure.

when this is done if there is the cut has probably been made into the ganglion or even into the third division, i.e. not far enough back If the section is made fibre by fibre with the hook the motor root will be seen deep to the sensory fibres usually it is a double band of

compact nerve quite unlike the extremely fine strands of the sensory root and running more vertically The fibres to the eye must be left uncut (indeed they are often left inadvertently being sometimes quite separate from the other fascicles) If it is especially desired to cut them (as in the rare neuralgias limited to the first division) they must be sought with a small blunt hook far up and medially In cases of severe second division neuralgia the operator ensures that the correct fibres have been chosen by tracing them forward to the origin of this division from the distal side of the ganglion He can estimate whether the fibres which he intends to divide seem to be clearly destined for that division The procedure is similar for neuralgias of the third division only

Fractional divisions that is section of the root fibres proper to the second or third division are most accurately made very close to the point of insertion of the root fibres into the ganglion In some cases to make assurance doubly sure the second division is cleared as it enters the foramen rotundum and coagulated electrically Although a very pretty operation can be done by freeing the whole root very far centrally the root being first pulled gently down by a hook above and then freed and raised up from below fractional divisions at this level sometimes lead to very curious and patchy anæsthesias of the face

The operation is now over except for the insertion of muscle grafts One is placed in the open sheath of Meckel s cave thus insulating the middle from the posterior fossa preventing cerebro-spinal fluid from leaking from the latter or blood entering from the former Any other doubtful bleeding point is also treated with a muscle graft and the wound is closed in four layers (muscle fascia, aponeurosis and skin) In an easy case the operation can be carried through in about 40 minutes and can indeed be done by those who make a point of it in a much shorter time. It is the most admirable of all operations for training the surgeon in the special technique of neuro-surgery

Difficulties.—(*a*) The chief difficulty in the early stages of the operation is adhesion of the dura to the lateral wall of the skull Unless great pains are taken the dura may be torn through and the temporal lobe lacerated It is difficult to recover from such a mishap but it can be done and no harm ensue (*b*) The next difficulty is to secure the middle meningeal artery and indeed most of the remaining difficulties are concerned with bleeding The entrance of the artery into the skull may be obscured by one of the little hillocks of bone which abound in the middle fossa. If one is in the way it can be very easily chiselled off It is immaterial whether the artery is coagulated electrically or occluded with a peg When the arterial groove is deep its margins are often sharp and when the artery is lifted out it may start to bleed from small punctures in its wall. This bleeding can be controlled by pressure with the end of the lighted retractor until the vessel is coagulated deeper in. Some surgeons confessed that having had so much trouble with the middle meningeal

artery they made a routine practice of tying the external carotid artery in the neck. This is not necessary if the niceties are observed. (c) The next point at which there may be difficulties is the clearance of the dura from the third division It is important to remember that the middle meningeal vein runs out through the foramen ovale where it may be joined by a vein from the superior petrosal sinus on the outer side of this division Although bleeding from these veins can be very tiresome at times it is always arrested by leaving a muscle graft for a while and especially by coagulating the dura just deep to the stump of the middle meningeal artery The surgeon must cultivate equanimity in the face of bleeding which for the time being may completely stop the operation It is indeed remarkable how a bleeding point which bids fair to spoil the view so completely that no progress can be made will stop after a while and give no further trouble. (d) In some cases the sheath is very adherent and patience is necessary to strip it. This difficulty is commoner when alcohol has been injected into the ganglion on a previous occasion but it may occur for no apparent reason.

Complications.—There are only two complications worth mentioning facial paralysis and keratitis neuro-paralytica The former is uncommon It is due to traction on the petrosal nerve and transmission of the drag to the seventh nerve at its geniculate ganglion. This injury can always be avoided if the approach is made from the front of the third division and if sharp dissection is carried from that point outwards and backwards rather than from without inwards. The petrosal nerve can be cut in order to avoid any pull on it but it is better not to do so for its section leads to a dry nose and diminished tear secretion Neuro-paralytic keratitis does not occur with fractional sections of the sensory root it is most likely to appear in the earliest days after complete denervation but it may not make its appearance until weeks or months later

Neuro-paralytic keratitis is decidedly more common after injection and is guarded against by covering the eye with a Buller s shield for the first few days to prevent evaporation from the eye and to exclude the air It is wise to tell the patient to wear spectacles with protective flanges around the rim of the glass for the denervated eye so as to prevent irritation by gusty winds and grit (which will no longer be felt) Should a progressive keratitis develop it can be absolutely stopped by tarsorrhaphy the lids being kept closed for some months An eye need never be lost Dott advocates section of the cervical sympathetic in all cases where the cornea has been rendered numb as a prophylaxis against keratitis or as a cure for it but I am not convinced that it needs to be used as a routine Sympathectomy at the root of the neck certainly helps the rare case of trophic skin ulceration

It must be admitted that after partial sections an occasional recurrence takes place in the still sensitive area. Fortunately re-operations are extremely easy save for the difficulty of dissecting the

temporal muscle off the dura and of freeing the edge of the opening in the bone the whole way round. The deeper stages of the operation have a habit of being simple in the extreme.

In an average case the patient is allowed up on the second or third day and can be sent home at the end of the week. The mortality of the operation is less than 1 per cent.

In recent years H Wilkins and I Sachs in America and B C Hughes and J Small have preferred a trans temporal intra-dural operation. The preliminary steps are the same as those described until the dura is exposed. It is opened, the temporal lobe elevated and the site of the ganglion ascertained. A cut is made through the dura bringing the operator down on to the sensory root. This is a perfectly legitimate alternative but it makes no special appeal to me, neither does the Taarnhøj* innovation of decompressing the trigeminal root by division of the dura over it, which includes of course the superior petrosal venous sinus.

Alcohol Injections into the Gasserian Ganglion

The method of choice is the anterior of Härtel when the needle is introduced through the cheek into the foramen ovale and passes backwards obliquely into the ganglion. The lateral approach is not so uniformly satisfactory. All alcohol injections should be done under omnopon scopolamine medication. In old subjects gr ⅓–1/300 respectively is quite sufficient, indeed with larger doses they become so sleepy that they can no longer co-operate helpfully. The skin of the cheek is washed over with alcohol. I have found it imperative to use certain surface markings. The zygoma is carefully palpated and its mid point marked by a vertical line of iodine. By checking the inclination of the needle with which the ganglion is being sought in relation to this skin mark the worst errors will be avoided: the needle should be directed at it or even slightly in front of it (Fig 595). It should never be directed further back than this mid point. The usual fault is to direct the needle so far backwards that the carotid or even the jugular foramen may be reached instead of the foramen ovale. I have seen vagal and hypoglossal paralyses inflicted—a distressing mistake that could have been avoided had the slope of the needle been corrected in reference to a surface marking.

Technique.—A Labat needle 10 cm long is inserted a finger's-breadth above and behind the angle of the mouth through the novocainized skin; it can be used for anaesthetizing the ganglion when the operator is sufficiently expert. Graduated needles are not so imperative as they are for the peripheral division injections. The needle is passed upwards between the maxilla on the inner side and the internal pterygoid muscle on the outer and is directed upwards, backwards and medially to strike the external pterygoid plate. Since it

* P Taarnhøj, "Decompression of the Trigeminal Root, etc.," J Neurosurg 1952, 9, 288.

is important to cause as little pain as possible the often extremely tender bones of the base of the skull must be rendered anæsthetic with novocain. One of the most painful places is the external pterygoid plate which must be made analgesic if the third division is to be easily distinguished The foramen ovale lies immediately behind the point of attachment of the pterygoid plate to the base of the skull and slightly external to it A low ridge of bone, the



Fig 595.—Alcohol injection of Gasserian ganglion.

pterygo-spinous crest runs from the sphenoidal spine to the pterygoid external to the foramen and as Morris pointed out, it may rarely be high enough to prevent the needle from engaging in the foramen The tip of the needle is coaxed over this obstruction and should strike the third division an occurrence which the patient will generally signalize involuntarily In all cases aspiration should be carried out when the needle is through the foramen because cerebro-spinal fluid may disconcertingly be obtained Two drops of 2 per cent. novocain are injected into it and the lower lip tested for anæsthesia after a minute. It is important to allow a reasonable interval for the Novocain to take effect before the point of the needle is moved If

the test is positive the needle is pushed in a further centimetre and a little more Novocain introduced but not too much or it will dilute the alcohol and make it ineffective The needle should not be advanced farther than one centimetre through the foramen The face must be tested now to determine the extent of the numbness alcohol can then be injected without pain On an average about 0 8 c.c of 90 per cent alcohol is the correct quantity The surgeon should make this injection drop by drop watching meanwhile for dilatation of the pupil and testing the eye movements so that he can stop at the slightest signs of ocular paralysis It would be unwise to say that paralyses never occur or that they are always due to glaring errors in technique They can happen when the greatest exactitude has been observed Fortunately they are usually transient recovering in any time between a few hours and five months

The result may be a complete anæsthesia of the whole trigeminal area or only a partial one. It is complete nonsense to maintain that both partial and permanent anæsthesia of any given part of the ganglion can be effected consistently at will Study of Fig 595 suggests that small quantities of alcohol could possibly be so placed in the ganglion as to destroy only a few cells in a selective way but effects of such minute quantities are uncertain and fugitive. Occasionally the partial anæsthesia may be exactly the one required but it may be quite the other way with every part anæsthetic but the one needed It is possible to get a dense anæsthesia of the first and third division with a very slight effect on the second where the neuralgia may be worst. *In that case there is nothing for it but to* admit the failure and repeat the injection. It is often wise to leave the needle in place for half an hour or even an hour In this way such anæsthesia as is due to Novocain or shock will pass away and a clearer evaluation can be made. Even so the exact distribution of a partial anæsthesia cannot be determined for a few days. As for the motor root it nearly always regenerates

Difficulties.—The chief difficulty is not being able to find the foramen ovale Practice is the only solution Injections should not be done by the occasional operator they are very difficult. It must be impressed again and again that the surgeon should not carry his search too far back—hence the skin mark Nor must he ever inject alcohol until novocain has reassured him of the correctness of his situation Some foramina cannot be entered because of anatomical peculiarities the highly skilled may surmount this difficulty by using a quite unconventional re-entry of the needle lower on the face Failure means that the sensory root must be cut. I have had much help in difficult cases from X raying the skull with the needle *in situ* A basal projection gives valuable information on the position of the needle There may be difficulty from bleeding the cheek and face swell (especially in those with a very high blood pressure) when the internal maxillary artery is wounded. Blood from the internal

pterygoid plexus of veins may escape from the needle when the stylet is removed but there ought to be no bleeding once the needle point has actually entered the skull If the needle were directed too far backwards the carotid artery or jugular vein might be punctured.

Complications.—Neuro-paralytic keratitis (*see* p 1482)

The Choice of Method

The protagonists of the two methods have commonly denied, with a fervour reminiscent of mediæval theology the possibilities of there being any good in the other Both methods have their place both have good points and neither is perfect The best armoured person in the treatment of neuralgia is obviously the person who can do both *The common practice amongst neuro-surgeons to-day is to perform* fractional root sections for patients with tic douloureux limited to one division or two This rule is based on the fact that it is possible to give lasting relief of pain without rendering the whole face numb and without incurring the risks of the anæsthetic eye (unless the ophthalmic division is the only one affected which is very uncommon) Alcohol injection is reserved for the minority who have three-division neuralgia and for those who by reason of other infirmities are bad surgical risks (e g very high blood pressure diabetes cardiac renal and bronchial invalids) Advanced age is not a contra indication to open operation but I prefer injection for patients over 70 except in special circumstances I am aware that sections have been successfully carried out in persons of 80 and more years of age and indeed there is no reason why a limited largely extradural operation should not be well borne at any age. But most will agree that a major procedure on an old person is best avoided if there is an alternative Ganglion injections have the advantage that they give when the anæsthesia is complete as permanent relief as does root section but a full anæsthesia may fade and I have seen patients come to operation who had lost an eye after injection only to have sensation and pain return two or three years later It should be added that peripheral injections have a place in treatment they are advisable as preliminaries to give the patient an idea of what the permanent numbness will be like. There is no point in continuing with peripheral injections except in special cases if the patient s cardio-renal system is normal and indeed experience has shown me that patients will not tolerate this practice.

DIVISION OF THE EIGHTH AND NINTH NERVES AND OF THE TRIGEMINAL THROUGH THE POSTERIOR FOSSA

The division of the fifth eighth and ninth nerves through the posterior fossa can be described together the approach is very similar for all

Indications

Fifth nerve.—Division of the sensory root close to the surface of the pons has been held by some (Dandy Olivecrona) to possess

advantages over the more usual section in the middle fossa (*see* p 1476) The operation can be easier by this route than by the middle fossa on the other hand veins crossing from the cerebellum to the petrosal sinus may make it much more hazardous In general the posterior approach should only be used when the middle fossa method has been tried already on one or two occasions by other hands without success or in patients with malignant infiltration of the ganglion (carcinoma of the mouth naso-pharyngeal endotheliomas) where division must be very far back and combined with section of the ninth nerve The routine use of this approach is excellent preparation for the surgery of the acoustic neuromas It is not without significance that the most radical operations for these tumours were first most strongly advocated by those surgeons who operate on all trigeminal neuralgias through the posterior fossa.

Eighth nerve—There is only one indication for division of the eighth nerve the labyrinthine crises of vertigo (so-called Menière s phenomenon) In cases which are not cured by medicinal treatment vestibular neurotomy gives excellent results

Ninth nerve.—Glossopharyngeal neuralgia can be cured by division of the nerve intracranially Avulsion in the neck affords more than temporary relief according to some and is an alternative. Recurrence may follow either method suggesting that vagal filaments may sometimes be neuralgic mediators and usually I cut the uppermost vagal rootlet (intradurally) as well especially if there is only a single glossopharnygeal fibre in the root.

The Operation

The patient lies prone on a cerebellar head rest the shoulders propped in the usual way to allow free breathing A unilateral incision is made running up the mastoid from its tip just within the hair line Reaching the superior nuchal line it turns horizontally inwards and finally slopes downwards (Fig 596) A vertical incision as for an acoustic neuroma is just as good. The bone is drilled and freely removed laterally with the object of getting exposure as close up to the mastoid as possible. Internally the removal goes to the midline but it is not necessary to remove the whole of the edge of the foramen magnum as is always done in operations for tumours An important step is the release of cerebro-spinal fluid from the cisterna magna. Bearing this in mind the surgeon must remove just enough bone medially to allow exposure of the cistern The cerebellum cannot properly be retracted to allow full exposure of the cerebello-pontine angle until the cerebro-spinal fluid has been drained away from the cisterna magna so the first step is the opening of its arachnoidal veil After all bleeding has been stopped the dura is incised and sutured to muscles below and laterally An illuminated retractor is inserted down the lateral border of the cerebellum the

surface of which is protected from casual contusion or laceration by wet lintine strips A de Martel retractor may be fixed in place if desired

(*a*) **Division of the glossopharyngeal nerve.**—The nerve will be found rather more inferiorly than laterally The vagal group of nerves lies very close to the auditory and facial The cerebellum

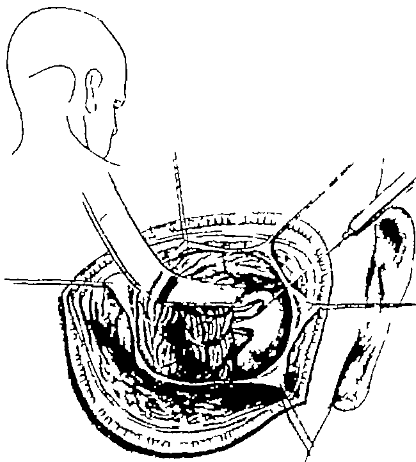


Fig 596 —Exposure of 7th to 11th nerves in posterior fossa section of eighth nerve Ninth nerve is the most anterior of vagal group.

must be considerably retracted before the nerves come into view If there is any difficulty in locating the vagal group the spinal accessory can be found as it turns up through the foramen magnum and can be traced to the foramen lacerum posterius There it joins the fan-shaped series of vagal roots of which the topmost is the ninth nerve It is thicker and often a little whiter than the vagal filaments and may be present as a double thread. Often a tough strand of pia separates the glossopharyngeal from the vagal fibres making it a simple matter

to distinguish between them In any case the surgeon knows that the most cephalad band is the nerve that he seeks It is picked up with a fine hook and cut There is no bleeding

Division of the eighth nerve—The approach is the same as before Indeed whichever of these nerves is being sought it is certain that the others will be seen The auditory nerve appears as a thick white band marked with a very fine single vascular stripe The facial nerve is deep to it and not visible until the more superficial auditory nerve has been gently and carefully lifted away from it or cut through. A fine veil of arachnoid runs off the cerebellum on to the nerve and must be torn with a fine long handled rectangular hook Until this has been done the cerebellum cannot be tucked back to expose more than the first two or three millimetres of the nerve The facial and auditory are most easily separated close to their origin they are most intimately applied to one another where they enter the internal auditory canal The fine right angled hook is slipped under the auditory nerve from above and eased along it towards the porus A curved hook cannot easily be made to do anything but pick up both facial and auditory nerves together The whole nerve can now easily be cut on the rectangular hook There is evidence that the vestibular fibres are cephalad to the cochlear and that section of the former alone will stop vertiginous attacks without suppressing hearing altogether Most of these patients are very deaf already and the final eclipse of hearing brought by complete neurotomy is no serious loss The surgeon may feel that it is worth while to try to preserve what little hearing there is but in my experience complete division of the eighth nerve gives more certainty of cure than partial section However K McKenzie of Toronto who has worked so fruitfully on this problem is convinced that complete section is not necessary The internal auditory artery requires mention it often forms a loop dorsal to the nerve but may have almost any relation to it. It is variable in size It can always be avoided and coaxed out of the way during the essential steps in the isolation of the nerve. Vascular anomalies have been suggested as the cause of vertigo but such evidence as there is favours a peripheral (labyrinthine) cause for the vertiginous attacks (Hallpike and Cairns) The dura is closed to prevent oozing from the muscles entering the posterior fossa.

Division of the sensory root of trigeminus.—The approach is the same but the nerve lies considerably deeper The operation is neat quick and often very easy The occipital bone opening may well be made a little fuller especially upwards The cerebellum is retracted as before after releasing cerebro-spinal fluid from the cistern and the seventh and eighth nerves identified A narrow retractor is slipped in between these nerves and the tentorium The first difficulty may be met in the attempt to do this the impediment is a vein crossing from the cerebellum to the junction of the superior petrosal with the lateral sinus in the angle It may or may not be present

It must be looked for coagulated and divided for if it is accidentally torn much time will have to be spent in controlling the bleeding Fibrin foam may be placed over the dural end of the vessel if it should continue to bleed coagulation on the bone is useless. If this vein is not present or after its division the cerebellum can be nicely retracted. Since the sensory root emerges from the pons, the retractor must gently be insinuated deeply Good illumination is necessary a good headlight and a suitable retractor Two centimetres medial and superior to the auditory nerve the thick white band which is the trigeminal root will be made out (Fig 597) Veins always pass forwards from the cerebellum to the inner end of the superior petrosal sinus close to this root On rare occasions they

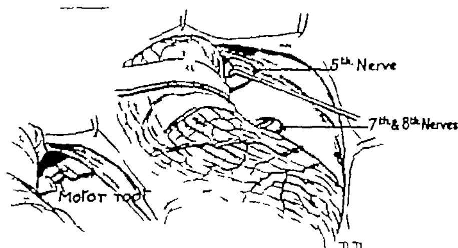


Fig 597 —Division of trigeminal root by approach through posterior fossa.

obscure it if so they must be coagulated but it is best to try to hook the root down or away from them A bad venous hæmorrhage in this situation might well mean an end to the operation (and possibly to the patient) If the root can be reached but not separated from the veins it will suffice if a silver clip is firmly applied to the root and vein as well (Olivecrona) A special long clip-forceps (Stille pattern) is needed for this and indeed the operation should not be done without it The fibres of the trigeminal root can easily be distinguished they run more directly forwards than any other visible nerve in the posterior fossa Further the trigeminal is a very large nerve and easily identifiable on this ground alone It can be torn through or cut wholly or in part The motor fibres are not easily included in such a division for they form a separate fascicle slightly medial to the sensory fibres. The deepest of these latter are those of the ophthalmic division and will best be left uncut for the average case. It is said to be possible to stop neuralgic pains without producing deep anæsthesia of the face if only half to two-thirds of the sensory root is divided. This is true of section in the middle fossa also but by neither

approach is it constant Probably neuro-paralytic keratitis is rarer than after neurectomy through the middle fossa The only disadvantage is that inadvertently caused venous hæmorrhage from one of the large vessels especially the deeper ones may lead to frank disaster I have not personally met with such a happening but it is known to have occurred. Care must be taken not to overstretch or bruise the seventh and eighth nerves during the approach They might be injured if any sudden hæmorrhage occurred and packs were inserted without thought for other possible damage It need hardly be said that perfect anæsthesia is necessary for these lateral recess operations If the cerebellum is blown up tight by congestion so that it cannot be delicately drawn on one side the operation should be abandoned for the day

Should the dura be closed or left open ? If the cerebellum has been badly bruised (it ought not to have been) it will be best to leave the dura open to allow for post-operative œdema If there has been much bleeding from the muscles and if the cerebellum looks very neat it is well to suture the dura to prevent oozing into the posterior fossa

For the technique of tractotomy the division of the fibres of the trigeminal root in the medulla which interrupts pain impulses leaving touch practically unimpaired the reader is referred to papers of O Sjöqvist the inventor G F Rowbotham and F C Grant *

INTRACRANIAL ANEURYSMS

The intracranial aneurysms requiring surgical consideration are most often extracerebral. Those of the posterior part of the circle of Willis are often inaccessible but if they spring from the internal carotid either before it pierces the dura (infraclinoid) or immediately afterwards (supraclinoid) intervention is possible

The indications for operation are two (*a*) if the aneurysm leaks giving rise to subarachnoid hæmorrhage (*b*) if a saccular aneurysm gives rise to focal signs Although the indications can be so succinctly stated the surgery of these aneurysms has aroused lively debate in recent years Opinion is divided between those who think that carotid ligature gives reasonably satisfactory results and those who affirm that the only sure way of dealing with them is by occlusion of the aneurysmal neck by metal clips or ligature No general laws can be laid down in favour of one method to the exclusion of the other The direct attack would be incontestably correct if all aneurysms had necks of a length and narrowness that made it possible to tie or clip them without at the same time kinking and obstructing the parent artery Only the smaller have a neck of that kind though so many seem to possess them on angiograms What in brief may be ideal treatment for the aneurysm may be disastrous for the patient. There are times when the risk must be taken especially when there is recurrent bleeding from an anterior communicating aneurysm The

* O. Sjöqvist, 1938, *Acta Psych. et Neurol.* Supplement, 17 Rowbotham, *Brit. Med. Journ.* 1939, ii, 1073. F C. Grant, R. A. Croft and F H Lewy *Arch Neurol. Psych.* 1940, xliii, 498.

majority of surgeons agree that few successes are likely to be gained by any method during the most acute stage of hæmorrhage that is during the first 1 to 2 weeks *unless* the patient has recovered his senses very promptly Experience proves that long continued coma or drowsiness is due to cerebral damage and not to blood in the subarachnoid spaces There are risks of increasing this damage by premature operation In this important way the bleeding from intracranial aneurysms differs from any other hæmorrhage in the body If a massive intracerebral clot is present it can be profitably *sucked out through a burr hole puncture* Carotid ligature has proved a good way of dealing with aneurysms of the carotid trunk There is no necessity to describe the anatomical exercise which carotid ligature is We have found it best to tie the common carotid first and the internal carotid a few weeks later because the incidence of hemiplegia is less that way Schorstein (1940) showed that neural damage after carotid ligation was due to cerebral anoxia and not to propagating thrombosis as was formerly thought. Of 252 aneurysms treated in the University Department of Neuro-surgery in Manchester the carotids were tied in 196 None died as the result of the ligature but 20 died from the aneurysm from 2 weeks to 6 years later In the 46 cases where direct attack was made 5 died but some of these were fruitlessly operated upon when almost moribund.

As an illustration of the direct attack a brief account will be given of the ligature of a middle cerebral artery aneurysm. First there is an absolute necessity to obtain the best possible X ray pictures of the aneurysm Second bilateral angiograms must always be made for two reasons (*a*) to test the collateral circulation in the circle of Willis which is done by compressing the carotid opposite to the one being injected to see if the contrast fluid goes across to the other side if both carotids are left free the vessels fill only on the side being injected (*b*) to make sure whether there is another silent aneurysm on the other side as there is in perhaps one-tenth of the cases

Ligature of middle cerebral aneurysm.—Approach is made on the relevant side as for a pituitary or polar frontal tumour and intra durally The frontal lobe is retracted upwards the lesser wing of the sphenoid reached and the Sylvian fissure inspected *in its whole* length from the lateral surface of the brain to the internal carotid medially This is an unusual view of the fissure which is next opened up by careful dissection. The middle cerebral artery is buried in the fissure it has a short trunk which breaks up into three or four branches. The aneurysm is usually at one of these bifurcations i e. about the middle of the exposed area. The aneurysm is most often buried in the lower bank of the Sylvian fissure but its site can be detected by a discoloration of the thin cortex overlying it The brain around it is carefully sucked away and the parent artery exposed medial and lateral to the lesion When the sac has been sufficiently freed a

ligature is placed around its attachment to the artery and tied care being taken to exclude from the ligature any adherent branch In order to avoid the tiresome consequences of rupturing the aneurysm during dissection many surgeons prefer to induce hypotension most by drugs fewer by bleeding and intra arterial replacement Hypotension can only be allowed during the short time that the aneurysm

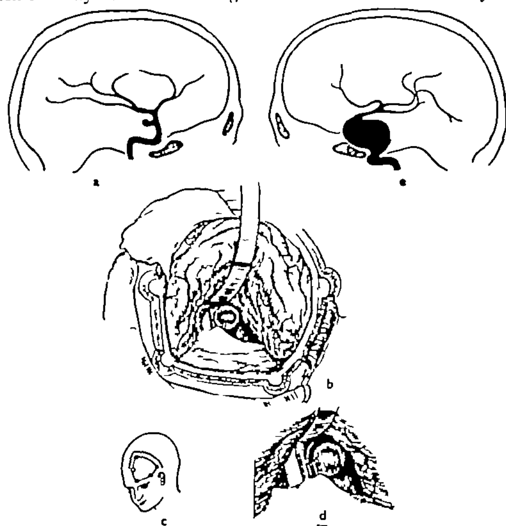


Fig 598 —Exposure of supraclinoid carotid aneurysm.

a, angiogram of supraclinoid aneurysm. b supraclinoid aneurysm exposed. c, skin incision. d, silver clip applied to aneurysmal neck. e, angiogram of infraclinoid aneurysm.

is being dissected out because continued lowering of pressure only too easily increases existing nerve damage by relative anoxia If the aneurysm ruptures when the blood pressure has been lowered to say 60 mm Hg the hæmorrhage is usually controlled without much difficulty

When ligature of the internal carotid has failed to cure a caroticocavernous fistulous aneurysm (with pulsating exophthalmos) Dandy to stop the down flow from the circulus Willisii clipped the internal carotid artery itself immediately after it has penetrated the dura I have often done this It is a good plan

THE SURGERY OF CRANIO-CEREBRAL TRAUMA

The interpretation of the neurological phenomena of head injuries of concussion and contusion has varied from time to time as now one now another philosophical dogma has had its day Operative treatment has been favoured discredited and popularized again each alteration has marked an important forward step paradoxical though that may sound. In general the treatment of the contused brain remains a non-operative one but we are increasingly ready to intervene. We reserve active treatment of one kind or another for the epi phenomena of head injury extra- and intra-dural hæmorrhages œdema and infection. When therefore we say that the treatment of

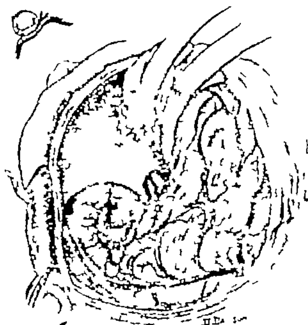


Fig 599 —Exposure and ligature of aneurysm of left middle cerebral artery in Sylvian fissure.

head injuries is largely conservative we mean that it consists in the cultured withholding of possible operative steps unless developments prove their need. Besides these intradural indications for operation, another important one may be found in the state of the skull itself open fractures always demand intervention especially those involving the para nasal sinuses. It is beyond the scope of this book to discuss the management of head injuries or to give advice on the treatment of cerebral œdema, meningitis or on the basic state of contusion itself

Open Depressed Fractures

Whenever the exploration of a scalp wound reveals a depressed fracture operation must be performed at once. There are no exceptions to this rule only a *closed* depressed fracture can be left alone.

Open injuries vary greatly in severity In some there is merely a pond or stellate depression of no great size In others part of the frontal of the squamous temporal or of the parietal bone may be driven through the dura so that the brain matter exudes Although the local injury may be alarming consciousness may be retained for that is not the function of any localized portion of the cortex or of the frontal lobes Circumscribed damage is therefore quite consistent

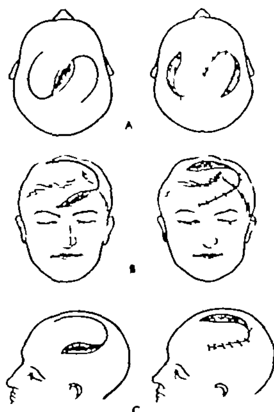


Fig. 600 —Diagram to illustrate principle of turning flaps to close scalp defects after excision of the wound. The aim is to secure a wound without tension over the underlying brain wound. The raw areas left after closure may be Thiersch grafted immediately or subsequently (*see* text)

with relative alertness on the part of the patient Profound unconsciousness is a legitimate cause for hesitation because it indicates wide injury to the brain base and stem

Technique.—No detailed description will be given of the method of excising scalp wounds but it is impossible to over-emphasize the necessity for thorough cleansing and careful excision of all scalp wounds In what follows it will be assumed therefore that the surgeon fully understands his responsibility for dealing adequately with the overlying soft part injury

It is best to gain exposure after complete cleansing and sparing excision of the wound edges by prolonging its limbs until the fracture can be clearly seen if its ramifications are still obscured the incision should be extended. Extensions of wounds should be curved to

allow of the scalp being slid or swung and closed without tension. We have learned a good deal from the plastic surgeons and do not hesitate to swing considerable flaps. Some are illustrated in Fig 600 The scalp is so inelastic that a considerable enlargement of the wound is often required *if the site of the underlying wound is to be covered* in securely without tension This will often mean leaving an open gap elsewhere to be filled in temporarily with tulle gras and Thiersch grafted 4 or 5 days later It is common for the edges of the depressed bone to be jammed together so firmly that they are immovable. Sometimes fragments of dirt and scalp can be seen wedged in the cracks A drill hole is made or trephine disc removed over firm bone at the edge of the depression. With a pair of narrow pointed nibbling forceps the skull at the edge of the injured area is removed to the impacted fragments If they are seized and rocked out before they are loosened there is considerable risk that the dura will be lacerated, or if it is already injured that more and deeper damage will be inflicted on the brain. *With the proper forceps the bone fragments may* be carefully cut in such a way that they release themselves The necessary steps suggest themselves to the operator as he inspects the actual wound. Although it is bad practice greatly to enlarge the bone defect, it must be of a size roughly commensurate with depth of the brain wound as well as with its surface extent. It is so easy nowadays to close skull defects with tantalum plates or with perspex that one does not need to be so parsimonious about the size of the resulting hole in the bone as was once the case The opening shown in Fig 602 is a shade smaller than it should be The loosened bone having been lifted out the dura is washed over thoroughly with saline. If it is intact so much the better if lacerated brain oozes out and has probably been doing so already pulped cerebral tissue should be allowed to extrude under a stream of warm saline and removed by gentle suction. The surgeon must make sure that no indriven bone fragments are hidden in the injured brain though this is only common in gun-shot wounds The best way to ensure a clean wound is by judicious use of suction (Fig 602 and see later) The dural edges should not be interfered with nor the membrane excised because this opens up the lepto-meninges to infection The operation is completed by suture of the wound after dusting with penicillin-sulphamezathine powder The bone fragments must not be replaced because they are potentially infected.

Closed Depressed Fractures

The fashion for elevating all depressed fractures beneath an intact scalp is on the wane. It is certain that a moderate depression does no harm and that there is little risk of epilepsy developing later from the supposed pressure of the bone (*see* p 1510) Such damage to the brain as may sometimes be present is always produced at the moment of the accident and is not made worse by the depressed bone. On the other hand it is not always easy to be satisfied that the dura has

not been torn or the cortex lacerated A fair estimate of the probabilities can be gained only from the study of radiographs—especially of oblique tangential views—and from the neurological examination If it is then observed that bone is severely depressed that the fragments are acutely angulated or so far indriven that the dura can scarcely have remained uninjured or if there are focal signs it is wiser to operate The operative steps are similar to those enumerated above with this important difference that each fragment of bone should be carefully preserved washed in saline or Ringer's solution and replaced

Fractures Involving Frontal Sinuses

This particular type of injury which first came into prominence during the late war is potentially the most dangerous of the depressed fractures. It is most often seen in motor-cyclists in head-on collisions or head long falls by which the middle of the forehead is indriven (Cairns 1946) * The frontal squame is thus pushed back into the frontal sinuses the posterior walls of which are often splintered with laceration of the dura and (at once or later) a resulting meningitis or a cerebro-spinal rhinorrhœa. Not uncommonly during the ensuing days air from the nose may be blown by the patient inside the skull or into contused and prolapsed brain tissue (aerocele) It is by no means uncommon for the bones of the deeper sinuses to be crumpled by the violence of the impact if it is applied low down at the root of the nose. Not only the frontal sinuses but the ethmoids may be damaged their roofs lift and burst tearing the dura so that cerebro-spinal leakage takes place far back, even through the sphenoidal sinus Hence the surgeon must be prepared to search as deep as the pituitary fossa for the origin of a dural laceration or a fistula. The sites are shown diagrammatically in Fig 601 In these days of much more effective anti bacterial treatment there is no need to rush into instant operation though it has to be admitted that some cases have died from meningitis within the first three to seven days Others have died years later from infection creeping in through the basal crack. Generally it is more important that the operative steps should be well conceived and carried out than that they should be done at once delay up to several days is often justifiable and in fact some of these patients are not referred to a neuro-surgical centre until a week or several weeks have elapsed This is because rhinorrhœa may not be recognized at once or else the early X rays have not been good enough to alert the surgeons to the real extent of the sinus damage Tangential views through the orbits are needed to show up the ethmoidal roofs (Johnson 1948 † to whom we owe our knowledge of the frequency of ethmoidal damage) but a good idea of the probability

* Cairns, Sir H. W B., "Head injuries in motor cyclists." *B.M.J* 1941 ii, 465.
† Johnson, R T and Dutt, P., "On dural laceration over paranasal and petrous air sinuses." *Brit J Surg.* (War Supplement), 1947 84, 447
Johnson, R. T "Surgical aspects of meningitis in 'British Surgical Progress'" London, 1952.

of air sinus involvement can be gained from good antero-posterior and lateral views. Some of these lines are shown schematically in Fig 601

Technique —The scalp flap must depend on the state of the skin. Sometimes it is intact or healed and then a transverse Souttar type of incision just inside the hair line is good (*see* Fig 600) Otherwise

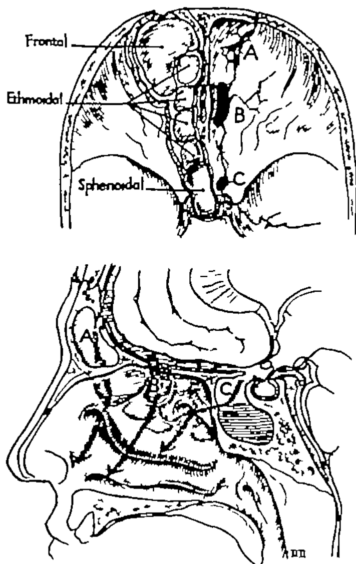


Fig. 601.—C.S.F Rhinorrhoea leakage may occur through a defect in the roof of the frontal sinus (A) ethmoidal sinus (B) or sphenoidal sinus (C)

judgment must be used to choose lines that will give as good a cosmetic result as can be hoped for A low unilateral frontal bone flap hinged on one temporal muscle but extending across the midline for 1½ in. is to be preferred Some surgeons cut out the centre of the frontal bones as a free flap exposing the frontal poles of both hemispheres replacing the bone of course at the end of the operation. Very often the injury is more severe on one side than the other so that on the

whole a unilateral flap uncovering some of the other side as well is sufficient but it must be possible to inspect both sides The dura is opened and the frontal lobe elevated until the extent of the damage to the brain and dura has been discovered Pulped brain is sucked away and bleeding points electro-coagulated The essential step in the operation is the closure of the dural laceration over whichever sinus it lies The dura here is too thin to suture and must be covered with fascia lata taken from the thigh This is laid intradurally and may be secured by a stitch of two but it holds in place well enough without when the brain falls down on to it It is not possible to repair the hole in the bone leading into the sinus in fact if there are upturned or loose fragments of sinus wall they are best removed The back wall of the frontal sinus may be removed completely and its mucosa wiped out. Although in many cases the frontal sinus is the one injured the dural laceration may be much deeper and must be sought for till found The treatment is essentially the same wherever the tear is (Fig 601) The results of this operation are highly satisfactory, a rhinorrhœa stops at once or very quickly depending on the adhesion of the fascial flap If it does not the real hole has not been found or there is a second one farther back or on the other side. Care must therefore be taken that the full extent of the damage has been truly seen however satisfactory the operation seems to be at the moment both frontal lobes should be retracted to make sure that nothing has been missed. Anosmia on the injured side is inevitable when the fracture is far back but it is best to try to preserve one olfactory bulb if circumstances permit and if both are not already destroyed by the accident Bilateral anosmia is most disagreeable and dangerous when gases cannot be smelled It is at all times a great handicap to cooks and to all normal people who like food

Gun shot Wounds of the Head

In warfare an attempt is made to segregate these injuries in special hospitals where they can be operated upon and looked after by teams supervised at least by those with neuro-surgical experience. Air transport has proved invaluable in bringing back the wounded to places where they can be properly attended to by specialist teams None the less some have to be dealt with by others with nothing but mother wit and surgical first principles to help them Apparently simple scalp wounds must be regarded with greater suspicion than those seen in civil life for the chances are great that there has been splintering of the skull or penetration by small fragments of metal No greater mistake could be made than to regard the surface injury as the only problem Competent X ray and pre-operative neurological examinations are indispensable for intelligent surgery Often enough some alteration in the power of a limb or in the reflexes indicates that the wound is not as innocent as it appears Operation is always necessary for gun-shot wounds and follows the general rules applicable to all injuries of this type It must be undertaken fairly

of air sinus involvement can be gained from good antero-posterior and lateral views Some of these lines are shown schematically in Fig 601

Technique —The scalp flap must depend on the state of the skin. Sometimes it is intact or healed and then a transverse Souttar type of incision just inside the hair line is good (*see* Fig 600) Otherwise

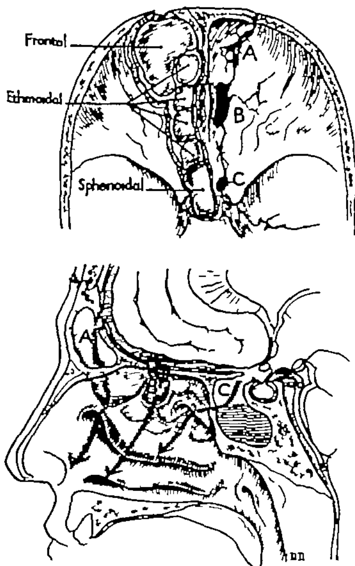


Fig. 601.—C.S.F Rhinorrhoea leakage may occur through a defect in the roof of the frontal sinus (A) ethmoidal sinus (B) or sphenoidal sinus (C)

judgment must be used to choose lines that will give as good a cosmetic result as can be hoped for A low unilateral frontal bone flap hinged on one temporal muscle but extending across the midline for 1½ in. is to be preferred. Some surgeons cut out the centre of the frontal bones as a free flap exposing the frontal poles of both hemispheres replacing the bone of course at the end of the operation. Very often the injury is more severe on one side than the other so that on the

whole a unilateral flap uncovering some of the other side as well is sufficient but it must be possible to inspect both sides The dura is opened and the frontal lobe elevated until the extent of the damage to the brain and dura has been discovered Pulped brain is sucked away and bleeding points electro-coagulated The essential step in the operation is the closure of the dural laceration over whichever sinus it lies The dura here is too thin to suture and must be covered with fascia lata taken from the thigh This is laid intradurally and may be secured by a stitch of two but it holds in place well enough without when the brain falls down on to it It is not possible to repair the hole in the bone leading into the sinus in fact if there are upturned or loose fragments of sinus wall they are best removed The back wall of the frontal sinus may be removed completely and its mucosa wiped out Although in many cases the frontal sinus is the one injured the dural laceration may be much deeper and must be sought for till found. The treatment is essentially the same wherever the tear is (Fig 601) The results of this operation are highly satisfactory a rhinorrhœa stops at once or very quickly depending on the adhesion of the fascial flap If it does not the real hole has not been found or there is a second one farther back or on the other side. Care must therefore be taken that the full extent of the damage has been truly seen however satisfactory the operation seems to be at the moment both frontal lobes should be retracted to make sure that nothing has been missed. Anosmia on the injured side is inevitable when the fracture is far back but it is best to try to preserve one olfactory bulb if circumstances permit and if both are not already destroyed by the accident. Bilateral anosmia is most disagreeable and dangerous when gases cannot be smelled It is at all times a great handicap to cooks and to all normal people who like food

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early because such wounds are always contaminated though often not so heavily as those of the limbs The patients should first be resuscitated the less severely injured being operated on first. Those who remain deeply unconscious have deep damage and will probably die in any event The object to be attained is complete mechanical cleansing from all devitalized tissue converting the open injury into a closed one with as little likelihood of subsequent infection as possible. The best anæsthetic is 1 per cent novocain adrenalin If the patient is restless he should be given evipan or pentothal. Instructions on the positioning of the patient, on care for his comfort for provision of a free air way and the arrangement of drapes has already been given on p 1496 The best types of incision are shown in Fig 600

Treatment of the bone.—Gutter wounds in the bone are opened up by nibbling the contused bone away all around, until healthy dura forms a fringe half an inch wide about the central perforation There may be difficulty in removing the bone at the edge of a gutter without biting away pieces of dura as well This dangerous mishap can only be avoided by making a drill hole in the bone so that the dura can be clearly seen and separated from the inner table. The drill is greatly superior to the trephine it is much quicker and less tiring—a very important consideration in military work where large not to say overwhelming numbers of cases may have to be dealt with. Recently the cutting of bone flaps has been advocated to allow more complete inspection and cleansing by suction Provided that the wound is recent and that the number of cases dealt with is not too great the bone flap has much to commend it

The dura and brain.—When the bone has been removed the dura is inspected. If it is intact it is only opened if there are positive neurological signs but more especially if the dura looks very dark for that indicates blood beneath it. If it is deliberately incised it must be closed again carefully When the dura is torn loose pieces of bone just below the surface are picked out with forceps and the wound washed over with saline. The pulsations of the brain cause an efflux of semi liquid cerebral tissue which can be aided by coughing As it exudes it may bring out with it further splinters of bone. All devitalized brain is sucked out until healthy undamaged tissue is visible all around a clean cone will be left Naturally the situation of the wound may limit the thoroughness with which this can be done (e.g motor cortex) Suction should be adjusted in power to remove pulped tissue but not to lift the only slightly tougher normal white matter During this sucker removal bone fragments are discovered and removed with fine crocodile forceps. The position of indriven bone fragments as well as of any missile must be carefully noted on pre-operative X rays the number of foreign bodies must be counted and checked as the operation proceeds. Finger exploration should never be used. The only objects that travel great distances into the skull are missiles they

may of course traverse right through without killing The search for and extraction of a deeply placed piece of metal should be undertaken only by the very competent a very deep missile is usually best left alone often it does no harm Shell fragments rarely weigh more than 10 grm or so very large ones kill the patient outright

The closure of these scalp wounds is more difficult than in civilian types for there is more loss of tissue and scalp is inelastic. Closure can be brought about by extending the limbs of the incision at such angles as will allow dissecting up of flaps Sometimes flaps of scalp can be swung across Plastic flaps planned on the Gillies principle

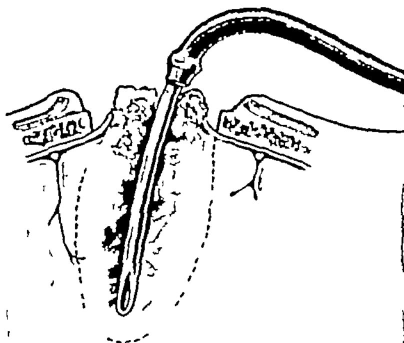


Fig 602 —Suction extraction.
The dotted line shows the area to be sucked out.

of rotation have proved most successful. Since the introduction of penicillin the routine firm closure of wounds has proven best, the once popular temporary drain is best avoided. Only when there is cellulitis should closure be delayed whilst the effects of chemotherapy are awaited Should the wound be already septic say after 4 or 5 days it should be opened up bone fragments removed necrotic brain sucked out and the scalp sutured It is incontestable that the biostatics have completely altered the outlook on and the management of open brain wounds It is now quite correct practice to close wounds where one would have hesitated 20 years ago Nor must the great value of the sulpha group of drugs be minimized because they have a saving value when pushed to really high concentrations in the blood and cerebro-spinal fluid (high titres are essential) in those examples where the wound flora are insensitive to available biostatics

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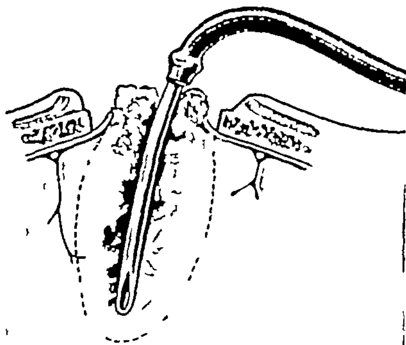


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INTRACRANIAL HÆMORRHAGE

There are few clinical syndromes so well known and so well as the classical syndromes of middle meningeal hæmorrhage and there is none which is so rarely seen in its perfect form. Both dural and intradural hæmorrhage have been recognized since cerebral injuries were first observed. The dangers of the forme made a much deeper impression on surgical practice than the During the last fifteen years the frequency with which the su and chronic subdural hæmatoma has been found and successfull with by the neuro-surgeon demonstrates the necessity for orientation Its operative handling is simple and no dou simplicity of the operative steps has been an encouragement i it has led to the discovery of clots that were suspected rathe firmly deduced from a train of classical symptoms and signs I it is well to operate on suspicion for both kinds of hæmorrhage results whether the clot be epi or intra-dural depend (1) rapidity with which the clot is discovered and (2) on the ext coincident contusion to other parts of the brain The recover in middle meningeal hæmorrhage is low a fact attributab fortunately as often to failure in diagnosis as to severe conco cerebral contusion Those cases do best in which the clots sufficiently slow evolution and in which the injury to the b insignificant. Better results are obtained from the chronic su hæmatomas those giving rise to symptoms some weeks or n after an injury

Operation for Extradural (Middle Meningeal) Hæmorrh

The operation for extradural bleeding is carried out as for te decompression There are two chief objects in this oper (1) to remove the clot (2) to prevent its recurrence by se the bleeding vessel. The first presents no great difficulty second can be very hard The size of the clot depends on the of adhesion of the dura. Experience in stripping the dura in the r fossa during operations for trigeminal neuralgia leads to the conv that some individuals must be immune from this type of lesi account of the closeness of the dural adhesion to the skull bu in others a potential cavity into which bleeding can occur mu *formed by the local loosening of the dura during deformation* o skull at the moment of injury When the hæmorrhage is p arterial there is little difficulty in arresting it but as Wood thought probable years ago in many cases there is venous ble as well. These are the difficult cases technically What happ that the arterial extravasation increases the potential cavity and strips the dura from the bone it sets off the same venous bleeding are encountered by the surgeon when elevating the dura from the of the middle fossa during the approach to the Gasserian ganglio comes from four sources (*a*) the middle meningeal vein (*b*) the sp

very rarely the cavernous sinus The control of this bleeding is not the simple matter that text book descriptions have usually implied

Not all extradural hæmorrhages are in the middle fossa. If on clinical grounds it seems that the patient ought to have a clot and none has been found it will then be right as K McKenzie (Toronto) advised to burr a hole an inch above and 2 in behind the ear to see if the posterior meningeal branch is the source of the bleeding Clots may even be frontal or more rarely cerebellar These alternative situations must be borne in mind although the account now to be given refers to the classically sited situation of the clot since it is the commonest

Technique.—If the patient allows his head to be prepared without violent struggling this should be done before he is brought to the theatre. If not the hair is clipped as short as possible and the final shaving done on the table. Under local anæsthesia or pentothal a vertical incision over the temporalis muscle is marked by a scratch before the drapes are applied It runs upwards over the temporal fossa from the zygoma below for a distance of 3 to 4 in. and is placed half way between the tragus and the external angular process The skin incision having been made with the usual precautions against unnecessary blood loss the temporal fascia is cut through and the muscle split to the bone of which as large an area as possible is bared with a raspatory without pulling the temporalis away from its superior attachment A self retaining retractor is now inserted and an opening made in the bone in the usual manner As *soon as this has been done the characteristic dark red clot is at once seen* with something more than a trickle of fresh bleeding oozing from around and amongst it The bone is nibbled away to make an opening some 2 in in diameter especially must the bone be taken away downwards The clot is removed with a spoon and gauze until the stained dura to which small pieces of clot are always firmly attached comes into view

It cannot be too strongly emphasized that decompression of the clot by removal of the temporal bone is insufficient Cases are known where death from middle meningeal bleeding has followed an operation for trigeminal neuralgia. This shows clearly that the presence of an operative bone defect will not save the patient unless all bleeding points are secured The next step is to ligature the middle meningeal artery proximal to its rupture This is most easily done by endotherm coagulation but if that is not available the vessel must be encircled with a suture of silk on a very small needle such as the Lane s cleft palate type larger needles cannot be manipulated in the cramped space It may be necessary to remove more bone to obtain enough room If the bleeding is purely arterial that is the end of the operation apart from wound closure but if as is often the case there are venous points still to be attended to these must be identified. Constantly washing out the wound and the use of suction under

experience necessary for correct management. Such failures as we have are too often due to the late admission of the patient after a sudden deterioration through compression of the brain stem the prodromal signs of which have been misinterpreted. The onset of coma and acute compression which comes sometimes with dramatic suddenness ought not to be the sign which makes the clinician think that the patient has a brain abscess and that it is time that he was sent for surgery

It was the advent of the antibiotics which has brought about a *radical alteration in the treatment and prognosis of brain abscess.* Nowhere is this more apparent than in metastatic abscesses secondary to bronchiectasis where the mortality has fallen from nearly 100 per cent to about 20 per cent at the present time. Even before the antibiotics became available many refinements had been introduced into the technique of drainage—such as the uncapping of the abscess by excising a disc of cortex over it the incision of the abscess wall under direct vision the sucking out of its contents the introduction of retractors and inspection of its walls with finally the placement of a drainage tube and of stitches tethering the abscess cavity to the dura (marsupialization) This was a good method but the basic fact is of course that penicillin must be not only put directly into the abscess cavity but kept there if it is to sterilize it an unstoppered drain would allow it to escape. Intramuscular injection of penicillin is of great value in healing the soft part and bone infection always present and should therefore be given but it is not enough by itself it must be put into the abscess and it must stay there to ensure sufficient concentration.

There is an alternative to the drainage technique and nowadays most surgeons prefer it because its results are so excellent. This is the closed method in which burr hole aspiration is carried out with instillation of penicillin or streptomycin into the abscess cavity through a cannula. At a later date the now sterile thick walled abscess capsule may be excised a subject that will be resumed shortly How frequently the abscess requires to be aspirated and penicillin or streptomycin injected depends entirely on the nature and behaviour of the organisms causing or co-partnering in the infection. Sometimes an abscess is already sterile and acts as a tumour (for which it can be mistaken) Sometimes a single dose of penicillin will sterilize at least for a few days But most abscesses require puncture and a fresh injection every two or three days to begin with. The real guides are three first the clinical state of the patient with special reference to alertness drowsiness headache and dilatation of the ipsilateral pupil second the vigour of bacterial growth and its laboratory tested sensitivity to the antibiotics the third point the pyogram requires a paragraph to itself For it is now customary to inject into the abscess on its first tapping 2 c.c. of thorotrast (E Kahn 1939) Subsequent X rays enable the surgeon to visualize the shape size and position of the abscess and what is more to observe whether it





PLATE III —Pyograms: antero posterior and lateral views of temporal lobe abscess

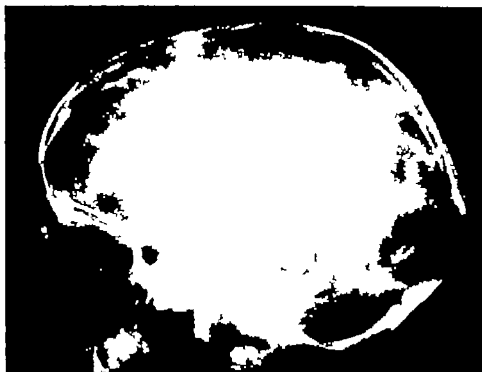




PLATE IV.—Pyograms: same case as in Plate III 3 weeks later; abscess shrunk and healing.

progressively shrinks or enlarges again X ray pyography plays an important part in the treatment of brain abscess (G K Tutton and W H Shepherd 1950) (Plates III and IV) A word of warning must be given about lumbar puncture in brain abscess suspects It is a dangerous procedure especially when the temporal lobe is swollen since a large withdrawal of cerebro-spinal fluid will almost certainly lead to an acute tentorial herniation and brain stem compression No more fluid should be withdrawn than will give the pathologists opportunity for a differential white cell count and chemical analysis Of these the cell count is the most important in the primary stage as a rough index of the severity of co-existent meningeal infection and its stage of development Whenever possible lumbar puncture should be withheld

Technique.—Little needs to be added to what has already been said, but there are a few problems that should be further discussed First find the abscess. An infected wound an area of osteomyelitis from a sinusitis or a Potts Puffy Tumour are obvious pointers Although it is beyond the province of this book to discuss diagnosis there is need to mention the difficulties that may attend the actual finding of a brain abscess or the decision as to whether one is really there Ventriculography may be a useful aid but in Manchester we have relied greatly on electro-encephalography (G K Tutton 1952) having found slow wave patterns in the cortex overlying an abscess an almost infallible guide when taken in conjunction with the history and clinical signs Having made as sure as possible where the abscess is a hole is burred in the skull over it under local anæsthesia the dura opened a 8 mm. thick cannula is inserted the sort used for ventriculography The capsule can be easily felt when it is reached if none can be palpated the stilette is withdrawn in case the infection is diffuse with only a small core of pus But usually if nothing can be felt the cannula has just missed the abscess and should be introduced in a slightly different direction When satisfactory contact is made the cannula is pushed in and held steady whilst the contents are allowed to drip out. Aspiration if used should be gentle because strong suction makes the abscess walls bleed. A specimen is sent immediately for smear and culture and identification of the organisms and 250 000 units of penicillin in 1 c c. and 2 c.c of thorotrast are injected. Thorotrast has no damaging effect on penicillin or streptomycin during the period of their greatest effectiveness Given a large abscess as when 50 c c. has been withdrawn, and that amount is a sizable sort of tumour in itself the patient s state shows great improvement within a matter of hours The need for repetition of the puncture depends as has been said on clearly recognizable data

Organisms insensitive to antibiotics.—The flora of some abscesses are insensitive to either penicillin or streptomycin A writer must hesitate to discuss the problem since any agents that he mention may be out of date before the print is dry Organisms insensitive

the relatively low concentrations used in bacteriological laboratories may yet be sensitive to a dose of a quarter or half a million units of penicillin confined within an abscess cavity Given such organisms as proteus or the coli group we have found Polymyxin B or chloramphenicol invaluable in large concentrations the latter substance, though not very water soluble can be used in micronized suspension. *The need for open drainage is rare only one case in the last 60 in* Manchester has needed it

Should a bone flap be turned? The answer is yes if the patient is not doing well and shows signs of pressure coning —an eventuality most likely with otitic temporal lobe abscesses. The object of the flap is to secure as wide a decompression of the infected lobe as possible. But in itself it does no good it is only useful in conjunction with vigorous and what is more effective anti infective measures Fresh punctures should be made to make sure that there is not another abscess (*See* below on excision of abscesses)

When should the causal infection be dealt with? Since most abscesses come from infection of the ear or nasal sinuses it is clear that rapid re-infection can only be prevented by the surgical treatment of the cause. The right time for this is very soon co-operation between the otologist and neuro-surgeon is most valuable and always to be encouraged. However it is certainly wiser to treat the abscess first. The giving of the general anæsthetic necessary for ear or sinus operation is unwise until the abscess has been found and aspirated and therefore *we have found it best to deal with the abscess first and the ear or sinus* two or three days later

Site of the **abscess.**—There is no important modification of the treatment wherever the abscess happens to lie—temporal *frontal*, cerebellar or if it is metastatic anywhere For cerebellar abscesses the bone over the affected hemisphere must be removed widely through a separate vertical incision or through a horizontal incision backwards from the mastoid wound There is no real hope of keeping these two wounds separate in a bacterial sense none the less a separate incision is preferable Cerebellar abscesses are not always easy to find since a smaller collection can give more trouble than one of similar size above the tentorium The principle of tapping and injection of penicillin is applied here as elsewhere. In the case of metastatic abscesses usually embolic from the lung (frequently the sufferer has bronchiectasis) pneumonectomy of the infected lobe should be done as soon as the patient is fit for it (Pennybacker and Sellors 1949)

Should the abscess be excised? Most neuro-surgeons have excised chronic brain abscesses intact often having mistaken them for tumours (Fig 604) Clovis Vincent (1937) was the first to propose this as the ideal treatment advocating the turning of a generous flap over the abscess to tide the patient over the early stages of the infection. The abscess was removed entirely some time during the following weeks. This no longer has the validity it once had but there

is one very clear indication for excision and an important one It is when the patient is not doing well with plain tapping Provided that the flora are amenable to sterilization the almost universal cause for failure to improve is that there is another abscess Most commonly *it will be found attached to the abscess already found (except of course* in the case of metastatic abscesses when it could be far away) and is often spoken of as a loculus This is an incorrect term if the word means an open pocket or diverticulum for the only sister abscesses likely to cause trouble are those shut off from one another Brain

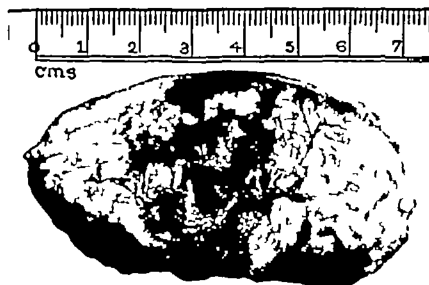


Fig 604.—Chronic abscess of cerebrum, successfully removed intact.

abscesses quite often form a conglomerate one large abscess with smaller ones attached and maybe only one of the smaller ones has been found. A pathological entity such as that could only be properly dealt with by excision after turning a suitably sized bone flap over it and dissecting the capsules out of the white matter If pus is spilled into the cavity it does not matter a great deal if antibiotics are flooded into the space after which the wound can be firmly closed. Loculation occurs in about 40 per cent of cases so that it really is a very important factor

A second possible indication for excision is epilepsy which occurs as a sequel to the healed brain abscess in about 50 per cent of cases (O V Jooma J Pennybacker and G K Tutton 1951) * But here it must be insisted upon the real point is that it is the damaged cortex in the neighbourhood of the abscess which is the cause of the fits and not the shrunken abscess If this cortex is excised widely there is a good prospect of the fits ceasing or at least diminishing in severity The scar of the abscess and its remains can be taken out conveniently at the same time but it is the cortex to which the surgeon

* J Neurol. Neurosurg. & Psychiatry 1951 14 308.

must pay attention. Direct electro-corticography from the exposed brain is valuable in identifying the epileptogenic focus (*see* later) *

CRANIAL DEFECTS, CEREBRAL SCARS, AND EPILEPSY

Holes in the skull and epileptic fits are both physiologically and surgically two different conditions. The only possible linkage is when a large defect leads to wear and tear on the underlying brain through its unprotected state and the altered hæmo-dynamics brought about by large holes.

The only types of epilepsy which can be cured or relieved by the surgeon are those in which there is a cortical scar Injuries which penetrate the dura damage the cortex and are therefore highly potential causes. Epileptogenic scars may be caused by the various missiles of war or by such severe open or closed fractures as pulp a localized area of brain beneath them. The steps of an operation on such a case are shown in Fig 605 The real essential in that operation is not the closing of the cranial defect but the wide removal of damaged cortex Dead cells cannot cause fits it is the fringe area inhabited by injured but still functioning cells surrounding the central core of damage which fires off the epileptic fits. It follows that all abnormal cortex must be removed as Wilder Penfield who has spent a lifetime on this work has so fully proved. Long ago Victor Horsley was the first to operate on such cases he was well aware of this necessity for he excised cortex in his first operation of this kind but not so widely as we now know to be necessary Much of our present-day knowledge has been gathered from the exploration of the cortex by electro-encephalography either through the intact skull or by the direct placement of electrodes on the widely exposed brain (corticography) In this way the epileptic focus can be pin pointed. But on this point there seems to be a factor so far unmeasurable, namely the variable inherent tendency of different individuals to have fits.

The amounts removed in cortical excisions tend to increase as experience enlarges Following the lead given by Krynauw (Johannesburg) † Cairns ‡ McKissock, whole hemispheres have been taken out in the particular instance of juvenile hemiplegic epilepsy In those paralysed from very early life loss of the damaged hemisphere has not notably increased the pre-existing motor disability the patients can still walk after this operation As was mentioned earlier whole hemispheres have been removed from adults too in the hope of radical cure of some gliomas It would only be very exceptionally that this was a worth while procedure and then only on the right side.

It is beyond the intention of this book to give the detailed steps of brain excisions for epilepsy which are not particularly difficult.

Cerebral abscess, the present position." *Annals Roy Coll. Surg. Eng.*, 1953, 13, 281.
† Krynauw, R. A. Infantile hemiplegia treated by removing one cerebral hemisphere. *J Neurol, Neurosurg. & Psychiat.* 1950, 13, 243.
‡ Cairns, Sir H. W B., and Davidson, M. A. Hemispherectomy in treatment of infantile hemiplegia." *Lancet* 1951, ii, 411.

The real art is in discovering where the focus is As for clos he skull defects it is now simple to repair them with properly mc antalum plates Bone as shown in Fig 605 is a good ma of course but grafting is a tedious proceeding and not advisable so excellent an alternative exists or when as often happen

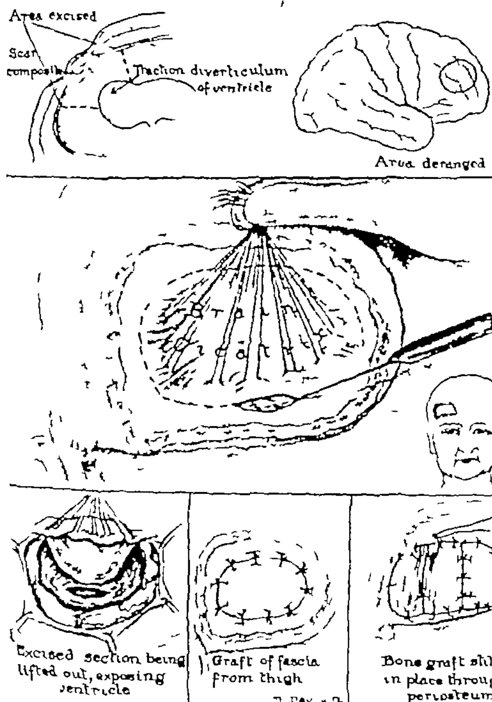


Fig 605 —Excision of traumatic scar and repair of skull defect by bone gra from tibia.

tender and painful the neighbouring tissues and lymphatic glands are apt to become swollen œdematous and tender One or more of three groups of lymphatic glands may be affected the pre-auricular the inframeatal and the superficial mastoid glands

The anæsthetic.—A general anæsthetic e g nitrous-oxide gas is necessary for all deeper-seated boils and when tenderness is marked local anæsthesia e g ethyl-chloride spray suffices only for very superficial furuncles

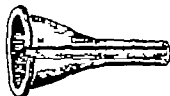


Fig 606.—Fenestrated aural speculum.

Local preparation.—The pinna is cleansed with ether or alcohol

Instruments. — Short small sharp-pointed knife small curette probe with wool and pure carbolic acid or picric-acid solution *fenestrated aural speculum (Fig 606)* forehead head light. The instruments are sterilized and arranged in the usual way and sterilized towels are placed about the patient s head and shoulder

A culture tube should be ready for bacteriological examination.

For this small operation the patient may be seated in a suitable (e g dental) chair or recumbent in bed if an operating table is not available

Incision.—As soon as the patient is anæsthetized the speculum is inserted with the fenestrum towards the centre of the furuncle and a free incision is made deep enough to let out pus The curette (Fig 607) *is quickly inserted and the slough removed. The excavation is swabbed*

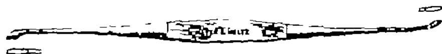


Fig 607 —Aural curette.

out with carbolized wool and the parts are cleansed. A small *strip* of gauze (plain or cyanide) saturated with glycerin is *loosely* introduced into the meatus covered with a dressing and lightly bandaged.

After treatment.—The dressing is changed daily *When there is* much pain or cellulitis fomentations may be applied but should be discontinued as soon as possible Insufflation with boric-acid powder or instillations of spirit drops are in many cases preferable to warm *aqueous applications*

Sometimes meatal furunculosis simulates mastoiditis There should be no difficulty in distinguishing these conditions but mistakes have been made!

THE MIDDLE EAR

The middle ear comprises the tympanum Eustachian tube mastoid and adjacent air cells and is developed from the first branchial cleft

ANATOMICAL CONSIDERATIONS

The normal drum membrane is a thin flexible disc which lies in an inclined plane and can be best recognized by the characteristic wheel spoke appearance of the handle and short process of the malleus seen in the upper half of the membrane The handle is directed downwards and backwards to the umbo or centre. At the upper anterior end of the handle the short process projects outwards like a small cone which is more prominent when the drum membrane is indrawn (or really in pressed by the excess of external atmospheric pressure) in obstruction of the Eustachian tube The cone becomes ill-defined in acute otitis media when the drum membrane is inflamed and the short process becomes unrecognizable if the membrane be infiltrated and bulging

In front of the umbo in the normal drum membrane the light is reflected to the eye from a triangular area often erroneously described as the cone of light (The true cone is the short process) This misnamed cone of light is inconstant for it may be replaced either by a small circular or by a crescentric lustrous area according to different degrees of inclination of the drum membrane in relation to the axis of the meatal canal

The extreme upper section of the drum membrane is sometimes lax and translucent— pars flaccida or Shrapnell s membrane Sometimes white circular opaque plaques are seen in the membrane either in front of or behind the malleus These opacities may be due to past inflammation but also occur without known cause or symptoms

The appearance of diseased or injured drum membranes is extremely variable there may be perforations granulations or scar tissue Discharge epithelial débris and wax must be removed before attempting to interpret the otoscopic appearances

The Eustachian tube leads through the lateral wall of the naso pharynx close behind the posterior nares upwards outwards and backwards into the tympanum The pharyngeal part of the tube is 2 to 2½ cm long and is smooth and flexible having a fold of cartilage forming its roof and inner wall. The tympanic portion of the Eustachian tube is a bony canal 1 to 2 cm long The osseous part of the tube develops from the cleft between three parts of the temporal bone which are not united at birth the anterior crus of the tympanic ring and the posterior margin of the glenoid fossa of the squamous part of the temporal bone externally and the lateral wall of the carotid canal in the petrous bone mesially In early infancy the tympanic ring broadens laterally into a trough Its anterior wall

expands becoming the vaginal plate to complete the glenoid fossa. The three bones eventually fuse to form the osseous Eustachian canal. The walls of the pharyngeal portion are in contact with each other except when separated by action of the palato-pharyngeal muscles during deglutition when the tube is opened momentarily Through the efficient mechanism of the tube the air pressure is maintained level within the tympanum despite changes of atmospheric pressure outside. Motoring in mountainous districts ski ing and flying make great demands on the regulative mechanism of the Eustachian tube owing to the rapid changes of altitude and of barometric pressure. Caisson workers and miners are for similar reasons especially liable to painful and disagreeable symptoms the Eustachian tubes failing to function normally during exposure to rapid changes of air pressure. Such symptoms include pain in the ear headaches deafness and especially when the disability is unilateral staggering vertigo and vomiting These disturbances arise quite apart from oxygen want or increased blood-oxygen.

The mucosa lining the Eustachian tube is columnar ciliated The cilia thrash towards the pharyngeal end Obstruction in the Eustachian tube is commonly associated with colds in the head adenoids and pharyngitis and is due to the hyperæmia or œdema of the mucous membrane

When swallowing fails to regulate the air pressure through the Eustachian tube one of three other methods may be adopted (1) The mouth and nostrils are kept closed while the patient forces the air from the lungs into the bulging cheeks and into the tympanum (Valsalva s and Eustachius s method) (2) The patient fills his cheeks with air and keeps the lips tightly closed as he occludes one nostril with the finger while the nozzle of a Politzer s bag is inserted into the other nostril. The bag is suddenly compressed to drive more air into the nose and pharynx and force open the Eustachian tube (Politzer s method) Alternatively the patient may swallow a mouthful of water instead of bulging the cheeks the Politzer bag being compressed as the pharyngeal muscles contract. Methods 1 and 2 are especially useful in children and much of Politzer s early renown was attained through the remarkable success of method 2.

(3) The modern method is by catheterization which in pre-Listerian days was undoubtedly dangerous and is usually unacceptable without local anæsthesia. Catheterization is preferable for diagnostic as well as for therapeutic purposes An auscultatory rubber tube with ear pieces enables the observer to detect when air enters the patient s tympanum through the Eustachian tube The catheter should be passed along the floor of the nose as far as the entrance to the Eustachian tube preferably after the preliminary application of a local anæsthetic to prevent palatal muscle spasm which often defeats the attempt The correct interpretation of different sounds produced by inflation can be made only after trial and experience Sometimes the sounds resembles those of the mucous râles heard in the respiratory

passages Other sounds are of air moving the tympanic membrane and escaping through a perforation which must be distinguished from the feeble sounds of air forced against the pharyngeal wall Care must be taken not to make a false passage with a catheter and cause surgical emphysema of the pharynx soft palate or neck

The **tympanum** is the air chamber in the middle-ear cleft between the tympanic membrane and the internal ear It is a narrow irregular cuboidal space with six walls Anteriorly it opens forwards and downwards into the Eustachian tube and postero-superiorly leads upwards and backwards to the mastoid antrum Inflammatory processes in the tympanum due to infection via the Eustachian tube are common causes of deafness and discharging ears The lateral wall of the tympanum is formed chiefly by the tympanic membrane but partly by the bone adjacent to the tympanic ring Timely incision of the membrane is necessary to drain inflammatory exudation from the tympanum e g in cases of otitis media and diminishes the liability to chronic disease and permanent deafness The roof of the tympanum or tegmen is a thin plate of bone which forms a small part of the floor of the middle cranial cavity Through this plate infection in the tympanum is able to penetrate the cranial cavity leading to meningitis or to abscess in the adjacent temporo-sphenoidal lobe The floor of the tympanum covers the jugular bulb and through this floor infection sometimes extends directly into the jugular vein causing septicæmia.

The inner or mesial wall of the tympanum is formed by the parts of the cochlea and vestibule of the labyrinth An elevation or promontory faces the drum membrane and is formed by the first whorl of the cochlea On the mesial wall behind the promontory is a depression bisected by a ridge of the two small fossæ thus formed the upper called the pelvis ovalis lodges the stapes the foot plate of which fits the oval window of the vestibule of the labyrinth and is maintained in position by means of an annular ligament which normally permits slight mobility The lower fossa or fossula rotunda lies opposite the lower or postero-inferior part of the drum membrane and is important because its anterior wall is formed by the membrana rotunda which separates the fluid of the cochlea from the air of the tympanum The function of hearing is affected by the condition of the membrane of the round window as well as by the mobility or fixation of the stapes fixation may result from disease e g otosclerosis Knowledge of the position and relation of the stapes is necessary to avoid its accidental displacement particularly during operations on the middle ear Dislocation of the stapes is a cause of post-operative labyrinthitis often followed by meningitis

Lying in the inner wall of the tympanum is the bony canal of Fallopius through which runs the facial nerve The canal curves from above the stapes downwards entering the posterior tympanic wall and ending lower down at the stylo-mastoid foramen Fracture of the temporal bone and inflammation of the middle ear are common

causes of facial paralysis There is also danger of injury to the nerve during operations on the ear

The three **auditory ossicles**—malleus incus and stapes—form a jointed flexible arch connecting the tympanic membrane with the labyrinth The incus (Fig 608 *C*) supplies the middle of the arch forming ball and socket joints with the malleus (*A*) and with the stapes (*B*) It pivots on the end of a short arm which rests on the floor of the aditus (*C*) i.e. the canal which leads from the tympanum to the antrum. The ossicular chain is like a lever of the first order with a median fulcrum. There are two intrinsic muscles acting in opposition the tensor tympani attached to the malleus (*D*) and the stapedius to the stapes (*E*) Acting together they control the rigidity of the ossicular chain the tension of the tympanic membrane and also the footplate of the stapes and thus vary the tension of the membrana rotunda through the perilymph of vestibule and cochlea Chronic suppuration in the middle ear sooner or later leads to destruction of the ossicles. The incudo-stapedial joint and the incus are generally the first to be destroyed

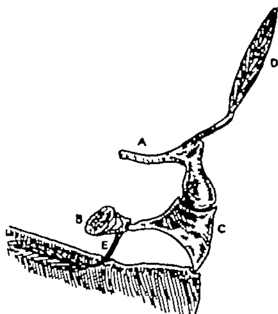


Fig 608 —The auditory ossicles.
A, Malleus B, Stapes C, Incus D Tensor tympani E, Stapedius.

OTITIS MEDIA

Acute otitis media is an infection of the mucosa lining the middle ear by organisms (pneumococci streptococci or staphylococci) which invade the cavity from the naso-pharynx An inflammatory process is initiated resulting in exudation of the products of suppuration into the normal air-spaces of the tympanum. (Fig 609) The infection may be localized or may be diffused throughout the mastoid antrum and accessory cells in the petrous bone

Children often fail to draw special attention to the ears when ill, though one or both may be infected. The sudden appearance of otorrhoea or the discovery of a superficial mastoid abscess may be the first sign of otitis media This serious condition can be overlooked unless a daily inspection of the drum membranes be made in all patients especially children with infections of the upper air passages associated with an exanthematous fever (including typhoid and

infantile gastro-enteritis) or with pneumonia though there may be nothing to direct special attention to the ear

Incision of the tympanic membrane will prevent deafness after otitis media and hastens recovery

Indications for myringotomy.—There is generally more or less pain or discomfort with some deafness in the affected ear though some

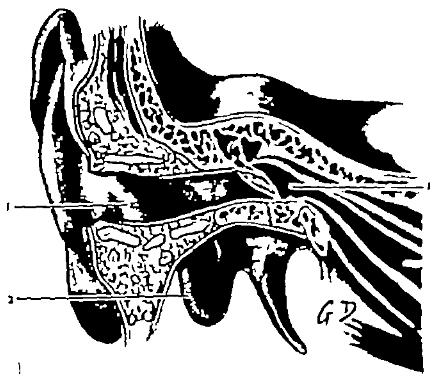


Fig 609.—Oblique vertical section of external and middle ear
1 External auditory meatus; 2, mastoid process; 3, tympanic cavity; 4, [illegible]

times the pain lasts only a few hours and is followed by a [illegible] numbness in the region of the ear

Anæsthetic.—A general anæsthetic should be given

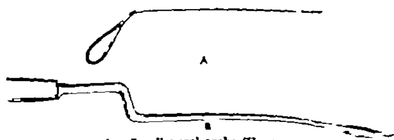


Fig 610, A.—Small aural probe (Hunter To[illegible]
Fig 610 B.—Myringotome.

Instruments.—Only three are essential a myr[illegible] straight bayonet-shaped or angular according to [illegible]

tome can be used in emergencies) an aural speculum—the largest the meatus comfortably admits a frontal mirror or head lamp

Preparation.—The instruments should be sterilized by boiling The operation can be done without moving the patient out of bed but an operating table if close at hand may be more convenient. The patient may be seated in a chair if the general condition permits The skin of the ear is cleansed with ether or alcohol but it is undesirable and quite unnecessary to syringe the meatus with antiseptics or to apply iodine to the drum

The incision.—The surgeon should introduce the speculum adjust the patient s head and the light and having removed any wax or epithelial débris should decide on the precise line of incision and make a clean cut across that part of the drum membrane which bulges If the landmarks are definable the incision should be behind the handle of the malleus The surgeon must take care not to thrust the point of the knife against the incus or stapes or to penetrate so deeply that he might puncture a high thin walled jugular bulb which is rarely associated with bony dehiscence of the tympanic floor

One incision should suffice Multiple incisions imperil the hearing If later the question of a second incision is raised it will only be because pain or pyrexia persists and in that case there will probably be additional reasons for opening the mastoid rather than lacerating the drum membrane A swab for bacteriological examination should always be taken and carefully protected from contamination during withdrawal.

Dangers.—In practice the dangers are negligible though dislocation of the stapes also hæmorrhage from a high thin walled jugular bulb have occurred

After treatment.—Immediately after the incision an aseptic dressing (no meatal plugging) is laid on and when consciousness returns a hot fomentation is applied but fomentations should not be continued as they seem to encourage septic infection of the skin about the pinna. Ichthyol and glycerine soaks or a kaolin poultice are useful. The patient may assume any desired position except the dorsal decubitus change of posture tends to aid drainage. Lying on either side with the face turned half-down is advocated on hypothetical grounds.

The local after treatment consists mainly in re-applying hot fomentations After a day or two an antiseptic non irritant lotion at the patient s temperature or (say) 101° F is used to syringe the ear as discharge becomes less blood-stained and more muco-purulent.

In from one to two weeks the discharge and pain should have ceased. Finely pulverized dry boric acid powder or better still penicillin and sulpha may then be insufflated Continuance of discharge in and after the third week should be a cause of some apprehension, and watchfulness

MASTOID OPERATIONS

Surgical anatomy.—The mastoid process is barely distinguishable at birth but develops rapidly during the first year. Contrary to the statement* that cells do not develop before puberty, fuller experience shows that they may be present even before the end of the first year. On the other hand, they may never develop even at puberty. In 80 per cent of normal adult temporal bones there are no cells in the mastoid process beyond the antrum, and in 80 per cent the mastoid process from base to apex encloses large thin-walled cells. In some cases the cells extend beyond the limits of the mastoid process, invading the root of the zygoma or the adjacent occipital and parietal bones, even to the apex of the petrous bone. This variable pneumatization accounts for the occasional infection in the apex of the petrous bone around the carotid canal beneath the semilunar ganglion. Sometimes cells envelop the bony labyrinth (Figs. 611, 612).

This chapter is concerned with the orthodox mastoid operations, but it is well to bear in mind that modifications are sometimes necessary to gain access to cells more remotely placed. Such a modification is Ramadier's operation through the carotid canal. Severe otitis media involving the extensively pneumatized temporal bone presents features which differ from those due to otitis media in acellular mastoids. In the former case abundant otorrhœa and tenderness over the whole of the mastoid and particularly near the apex are frequent, while the patient with a non-cellular mastoid is less likely to have profuse discharge or apical tenderness. Operations on the mastoid performed for mastoiditis in the acute stages nearly always reveal very cellular mastoids, while in those operations necessary in chronic otitis media the absence of a cellular system in the mastoid process is the rule. It is probable that the non-cellular mastoid in chronic otitis media has always been non-cellular. The disease may have become chronic because there was *no urgent indication for drainage in its early stages*.

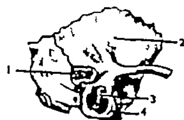


Fig. 611.—Right temporal bone in early infancy showing tympanic ring. Outer wall of antrum has been removed.

1. Antrum; 2, squamous portion; 3, malleus; 4, tympanic ring.

Relations of the mastoid antrum and cells.—The antrum and cells are behind the tympanum and external auditory meatus. A depression on the outer surface of the bone of the mastoid immediately above and behind the meatus (that is, the area of the suprameatal triangle of Macewen) is a safe surface guide to the antrum. The distance from the surface to the antrum varies considerably; the inner wall may be 8 cm. from the outer surface, but is sometimes only half that distance. When the mastoid process is cellular, it is safer to follow the chain of cells from the apex upwards and inwards until the antrum is reached.

Indications for opening the mastoid.—It may be taken as an accepted fact that the dangers of intracranial complications and the risks of

* Pyogenic Diseases of the Brain and Spinal Cord (W. Macewen).

protracted suppuration and permanent defect in hearing are evils which can be minimized by drainage of the middle-ear cavities through the mastoid region in those cases in which incision of the drum membrane only does not result in speedy recovery There is a group of cases of acute otitis media in which the mastoid cells appear to be affected almost from the onset of symptoms although the mastoid



Fig. 612 —Vertical sections of mastoid process to show (A) acellular and (B) partially cellular varieties.
A in oblique vertical plane, B in antero-posterior plane.

region is not necessarily tender to digital pressure Many examples of fulminating meningitis due to mastoiditis of a few hours duration could be cited. Let it suffice to quote one.

A medical student previously well awoke with earache after a visit to swimming baths Spontaneous discharge next day gave relief but in less than 36 hours the temperature rose to 102° and next morning was 104° Pulse 84 Semi-comatose at 9 a.m He died at noon eighty hours after the onset The autopsy proved that streptococci were spread throughout the meninges of both brain and spinal cord. Histological sections of the opposite frontal lobe cerebellar cortex and cauda equina showed the presence of long-chained streptococci in the pia-arachnoid in every section The mastoid cells were full of pus There was no excess of cerebro-spinal fluid and no anæsthetic had been administered

Tenderness is not necessarily an indication for immediate operation especially tenderness of the apex of the mastoid in the earliest stages of otitis media, as it often disappears within 24 hours if the tympanic membrane has been incised.

Whenever **mastoid tenderness** develops for the first time or persists or increases *after* the drum membrane has perforated or has been incised the necessity for opening the mastoid becomes clear Tenderness to quite gentle pressure with swelling or œdema may indicate mastoid periostitis. The common seat of initial tenderness to *steady* pressure is on the apex of the mastoid, but sometimes tenderness is confined to the base and often to one or more definite areas above or below the course of the lateral sinus

How in the absence of mastoid tenderness or swelling should one judge whether the drainage through the opening in the drum is insufficient and that the mastoid should be opened?

(1) The onset of **headache and drowsiness** indicate that there is no time for delay

(2) **Profuse discharge with pyrexia** —The amount of discharge is proportionate to the discharging area if its origin is in the tympanum alone discharge is never profuse Pyrexia shows that however free the discharge may be it is not free enough If pyrexia increases in spite of discharge or even if it diminishes but continues after say the fifth day the mastoid should be opened without hesitation

While a certain degree of pyrexia is the rule (101°–102 F) this may be quite slight (99°–100° F) and it is not uncommon to find the mastoid cells full of pus with normal or even subnormal temperature (97°–98 4° F) Exceptionally the temperature is 104° or 105 with no evidence of infection beyond the tympanum

(3) **Pain.**—When the discharge from the opening in the drum is not profuse but there is continuous pain deep-seated throbbing and pulse-like the necessary steps to open the mastoid should be taken within twenty four hours.

(4) **A furred tongue** is a useful general guide to infective absorption On the other hand the surgeon should not be deterred from operating because the patient has a clean tongue when pain or pyrexia accompanies the otitis media

(5) **Latent mastoiditis, extradural abscess** (Fig 613) —For some weeks after the inflammation of the drum has resolved and the hearing possibly returned to normal there may be latent suppuration in the mastoid cells or between bone and dura sigmoid sinus thrombosis or brain abscess or localized meningitis This type is more common and more latent since the general use of the sulpha drugs and penicillin which may mask the premonitory symptoms

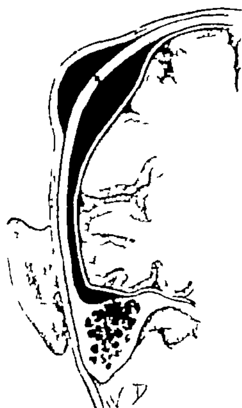


Fig. 613 —Extradural abscess: coronal section of head to show abscess originating in mastoid disease and pointing in parietal region, causing subpericranial abscess.
Schematic, to illustrate condition in a patient who recovered.

(6) **Swelling due to mastoid periostitis.**—An early sign of periostitis is the swelling sometimes seen in the roof and posterior wall of the *bony* meatus This so-called sinking in of the posterior upper wall of the meatus the result of periostitis in this region is an imperative command to open this [the antral] cavity (Heine quoted by Ballance) The surgeon must discriminate between swellings in the osseous and cartilaginous parts of the external auditory canal the former being associated with otitis media the latter with furuncles and otitis externa

It should be remembered that swelling and tenderness over the mastoid do not necessarily imply periostitis beneath. The application of a blister or leeches causes superficial swelling and tenderness and these measures however beneficial they may have been considered in the past confuse the issue and are therefore not now recommended On the other hand the lymphatic glands superficial to the mastoid may be infected from mastoiditis or from a furuncle or from an eruption in the scalp either of which may co-exist with otitis media.

(7) **Macewen s type of mastoiditis.**—The post auricular groove when compared with that of the opposite ear often shows early evidence of swelling The auricle may be displaced forwards and downwards owing to the conchal cartilage becoming separated from the os planum of the mastoid by the *inflammatory* effusion both in mastoiditis and in furunculosis It is not necessary in cases of mastoiditis to wait until superficial fluctuation is elicited

(8) **Zygomatic type of mastoiditis.**—The periosteal effusion may take an upward course leading to a swelling beneath the scalp immediately above the ear and spreading along the zygoma. When this condition is encountered for the first time the surgeon may fail to realize it as a complication of otitis media Recent literature contains numerous examples of this indication of mastoiditis

(9) **Bezold s type of mastoiditis.**—Pus may find its way spontaneously from apical mastoid cells into the digastric groove and so into the connective tissue of the neck beneath the sterno-mastoid muscle it may travel downward penetrating the upper cervical region causing rigidity of the sterno-mastoid with swelling and tenderness beneath *this muscle about the level of the transverse process* of the atlas vertebra. The abscess may very rarely open into the sheath of the sterno-mastoid and may point above the clavicle Or it may burrow forwards as a retro-pharyngeal abscess.

(10) **Severe giddiness with acute otitis media, or the onset of facial paralysis,** is generally an indication that the surgeon should prepare to open the mastoid

(11) **Persistent otorrhœa,** with the patient well and attending to his affairs In this group the surgeon may have to consider whether the mastoid operation is essential or not The otitis media may have been recognized early and treated by incision within a few days or the

patient may not have been seen until the ear had begun to discharge spontaneously The discharge seems to be quite free, there is no pain or discomfort no pyrexia only a certain degree of deafness little or no tinnitus but the discharge does not stop All active rhinitis has ceased there are no adenoids or infected tonsils and the possibility of maxillary or sphenoidal sinus suppuration can be outruled * Still

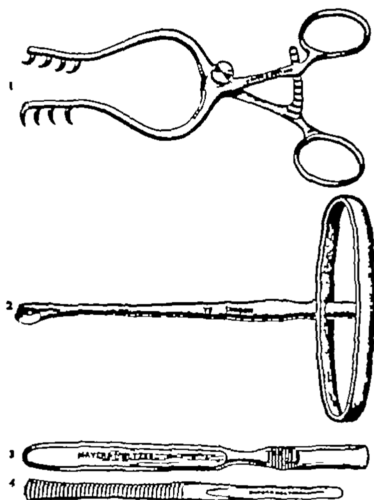


Fig 614 —1 Mastoid wound-retractor 2, cross-handled curette 3 periosteal elevator 4, gouge.

the otorrhœa continues though the patient feels well It may go on for three four six weeks six months nine months or even two years or longer without any serious disturbance of health or comfort. How long ought the surgeon to wait? What should he do? There is no polypus only a small perforation which oozes steadily and persistently The application of suction (Siegle's speculum) may draw out a bead of pus the discharge at first a little less re-appears but does not cease. Radiological examination may prove helpful.

* Cases of acute otitis media are not uncommonly associated with nasal-sinus infection; the latter may be overlooked unless sought as routine.

It should be borne in mind that persistent painless otorrhœa originating in adults especially when approaching or beyond middle age is rarely accompanied by those *external* signs of mastoid disease with which we are familiar in children and young people. The danger of alarmingly rapid onset of labyrinth infection often quickly followed by meningitis is too familiar to those who have much experience of this disease

There is no definite time limit by which to judge how long painless suppurative otitis media may continue but if *while under treatment* there is no further sign of the discharge diminishing the time for operation has arrived

Attempts to avoid the mastoid operation by total excision of the tympanic membrane and extraction of the ossicles are strongly disapproved in acute otitis media because hearing is irrevocably and

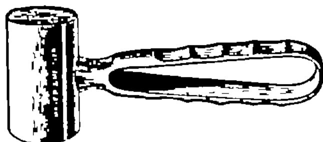


Fig 615.—Heath s hammer



Fig. 616 —Bone-nibbling forceps.

unnecessarily destroyed the dangers of labyrinthitis and fatal meningitis are greater than in the simple mastoid operation and the ossiculectomy may prove futile either not curing the discharge or only curing it at the price of lost hearing

Preparation.—The patient is prepared as for any other major operation The hair is shaved from the region to be dealt with and the skin cleansed with ether and alcohol When tenderness is marked and the patient timid or the general condition grave the surgical toilet of the head can be deferred until anæsthesia has been induced

The anæsthetic.—The choice may be left with the anæsthetist who will judge by age the state of the bronchi and lungs and the general condition He should allow at least half to three-quarters of an hour for the operation on one ear A preliminary injection of atropine is advisable

Instruments.—The special instruments required are a periosteal elevator a wound retractor gouges (various) a hammer curettes bone-forceps a head light and a myringotomy set. (Figs. 614–616)

Position —A convenient position is for the patient to be on the back with the face turned away from the side to be operated upon The surgeon stands by the patient s shoulder on the side to be operated upon The anæsthetist is at the opposite side of the table to the surgeon The chief assistant stands at the head of the table

Technique of Schwartze's operation —A curved incision is made through the skin behind the pinna beginning at its upper attach ment to the scalp (Fig 617) One which curves back semicircularly nearly as far as the hairy margin and terminates just behind the apex of the mastoid will prove more generally useful than one limited to the

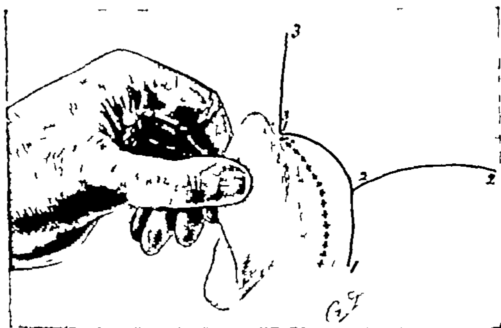


Fig 617 —Incisions for mastoid operations, etc.

1, 1 For Schwartze and radical mastoid operations ; 2, 2, extension for lateral-sinus thrombosis and cerebellar abscess ; 3, 3, extension for temporo-sphenoidal abscess. An incision following one of the dotted lines does not give such free exposure.

postauricular groove The surgeon then detaches and reflects the integuments forwards to expose freely the whole mastoid area. Three or four vessels may need the application of artery forceps

In the upper part the aponeurosis of the temporal muscle is exposed (Fig 618) but should not be opened unless involved in suppuration The periosteum of the os planum of the mastoid must be divided with the knife and detached forwards and upwards with the raspatory In the lower part the attachment of the tendinous fibres of the sterno-mastoid to the periosteum of the mastoid should be severed with the scalpel. This latter procedure should be carefully and thoroughly accomplished to prevent fragments and chips of bone adhering to the sterno-mastoid as they are apt to necrose and interfere with subsequent healing

The fibro-cartilaginous meatus is not detached from the bony meatus unless the posterior wall of the osseous meatus is to be removed

The self retaining retractor is now inserted (Fig 614)

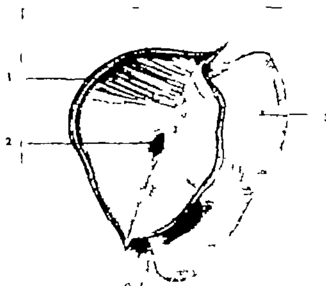


Fig 618 —Schwartze s operation, first and second stages incision and reflection of integuments.
1 Temporal muscle 2 suprameatal fossa 3 posterior surface of pinna

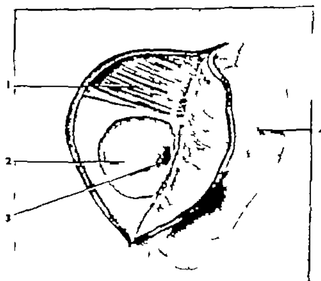


Fig. 619 —Schwartze s operation, third stage : removing the cortex.
1 Temporal muscle ; 2, operation cavity ; 3, antrum ; 4, pinna.

Having thus displayed the whole outer surface of the mastoid with the suprameatal spine and fossa the operator looks out for any superficial granulations or pus or sinus in the bony cortex. Thin

layers of bone are chipped away with gouge and hammer beginning say halfway between apex and base working radially upwards and forwards towards the suprameatal fossa (Macewen s triangle) (Fig 619) As the cavity deepens the chips are taken successively from the outer and lower edge of the cut bone the whole cortex from the tip of the mastoid and behind it is removed upwards forwards and inwards towards the antrum as the chief objective Whether containing free pus or only swollen mucosa each cell must be ablated and its walls levelled down Having dealt with the apical cells the operator may discover a chain of cells extending downwards from the antrum or backwards below the level of the sigmoid sinus or another chain more

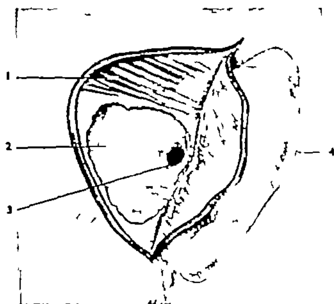


Fig 620 —Schwartze s operation, fourth stage opening the mastoid cells.
(For references see Fig. 619)

directly backwards above the level of the sigmoid sinus towards the petro-squamo-parietal sutures Again he may find other cells leading forwards in the roof of the osseous meatus and even into the root of the zygoma all must be opened up and obliterated (Fig 620) Opening the vertical chain of cells from the antrum may in some cases lead the surgeon to expose the facial nerve

The dura mater or the sigmoid sinus is likely to be exposed No harm will be done if care is taken to avoid even superficial abrasions of the dura. It is often well to expose the dura deliberately for thus an unsuspected extradural abscess is sometimes discovered In this event the surrounding bone is cut away more freely until the limits of the abscess and a ring of healthy dura are laid bare To do this special narrow bone-forceps may be useful. (Fig 621) If the wall of the sigmoid sinus appears to be thickened or discoloured it must be scrutinized with care for there is always the possibility of sinus infection even without the classical symptoms Apart from the external appearance the surgeon will consider the general condition

of the patient regarding pyrexia as well as the duration of the disease, before he decides whether to explore the interior of the sinus at once or to await further clinical developments.

Effectual drainage of the antrum and tympanum has now been provided and it is unnecessary to sever the tympanic ring unless the simple operation is deliberately to be converted into the radical.

In removing the outer antral wall special care may be necessary not to disturb the poise of the incus It is unwise to introduce a seeker

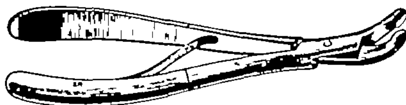


Fig. 621 —Narrow bone-nibbling forceps.

into the aditus or even forcibly to syringe into the antrum, for it is easy thus to dislocate the incus and should it be dislodged the hearing is permanently affected

When an electro-motor suction apparatus is employed to facilitate removal of blood during the operation the incus and even the malleus may be removed by suction if the suction tube is unintentionally inserted into the aditus!

The retractor is now removed and the small vessels are ligatured.

To close the wound completely is a method advocated by few surgeons* and not recommended here although some cases have been satisfactorily treated in this manner It is better to suture the upper part and insert drainage tubes at the lower end one long tube being sutured into the lower end for irrigation purposes Only when a peri-sinus abscess has been discovered should be wound be left more widely open the opposing surfaces can then be kept apart by introducing rubber strips This is much more efficient and comfortable than gauze plugging

The skin in the area operated upon and the hair at the back of the head are freed from any adherent bloodclot and dry dressings wool and bandage are applied If the first dressing be besmeared with sterilized petroleum jelly or saturated with glycerine its removal next day is greatly facilitated. The patient is then returned to bed.

After treatment.—The patient should lie on the healthy side and a nurse should remain by him in case of vomiting Pain occurs if the head is so placed that the sterno-mastoid on the side operated upon is extended To relax the muscle the face is turned to the opposite shoulder and the head raised on a pillow to incline the operated region towards the sterno-clavicular joint of its own side. When the operation has been performed on both sides the patient lies on one side

* E.g. the late Clarence Blake, based on the late Prof. Halsted's observations.

until consciousness returns He then is normally most comfortable on his back with a pillow to flex the neck and so relax both sterno-mastoid muscles

An early purgative a diet suitable to the appetite cleanliness of the mouth a four hourly watch on the temperature and pulse possibly an initial sedative—such is the routine in every case The surgeon must keep a continuous lookout for all signs suggestive of systemic or local intracranial infection the possibility of which should never be absolutely dismissed He must also expect to meet certain cases which develop acute cellulitis of the wound area after the infected mastoid cells have been evacuated and occasionally erysipelas

Local treatment.—For a few days severe pain may be caused by movements of the head but such pain can be prevented by avoiding active contraction or passive stretching of the sterno-mastoid muscle on the affected side. The patient should not raise the head unaided Nurses who move the patient should support the head and shoulders together keeping the head and neck flexed forwards with the chin inclined towards the shoulder of the unaffected side. As a rule the dressings need not be removed for several days. Nevertheless to change the first dressing in 24 or 36 hours makes the patient more comfortable. When both mastoids have been operated upon it is easier to carry out dressings painlessly with the patient sitting up and facing downwards to relax *both* sterno-mastoid muscles The second dressing can often be left on for two or three days When there is no cellulitis the sutures are left for five or six days Probably no more pus will be seen in the meatus only a little dry blood This can be left for a time the meatus need not be syringed unless pus is present

The tubes may be loosened about the fourth day One is removed at a time cleansed boiled and returned carefully into the track from which it was removed No useful purpose is served by forcibly syringing up the tubes or tracks and trying to make the fluid come out of the meatus or go into the nose!

When the tubes appear to be pushed out they can be shortened gradually Generally one tube should reach to the antrum as long as meatal otorrhœa persists

The painlessness of the post-operative course since the advent of penicillin is a feature

Secondary suture of an unclosed wound.—After the temperature has been normal for a fortnight the surgeon may close a wound which has broken down or been intentionally packed to keep it open up to this stage

In patients weakened by infection with tissues fragile and feeble in reparative power and particularly in children a delay of four or six weeks may be allowed before undertaking the secondary closure of the wound and then it should only be done if healing is far from complete or to correct disfigurement

If in spite of a satisfactory mastoid operation otorrhœa should

persist for some weeks the surgeon must seek and remove the cause. A simple mastoid should not be prematurely converted into a radical mastoid operation it may be better to prolong the mastoid antral drainage (i e. not to remove the antral drainage tube before the meatal otorrhœa ceases) seek and deal with any possible cause of infection in the nose and pharynx and pay careful regard to the general health. Post aural tube drainage was maintained for nearly twelve months in one patient with entirely satisfactory results. During this period the original wound was re-explored and no cause for failure discovered apart from chronic rhinitis (non-sinusitic) The alternative was to consider conversion to a radical mastoid operation (*see* below) which was avoided by the prolonged post aural drainage. The drum membrane healed and hearing became normal. Post-operative persistence of discharge is sometimes due to infection of a pneumatized apex of the petrous bone that is to infected cells in front of the cochlea or to perilabyrinthine cells—conditions which present special problems to the surgeon.

The Radical Mastoid Operation*

Essentially the so-called radical or complete mastoid operation is an extension of Schwartze s procedure. It includes resection of the

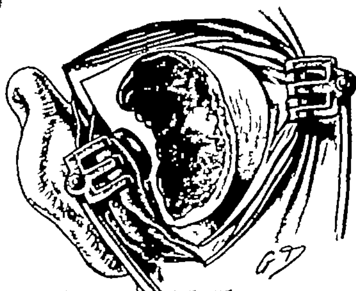


Fig 629 —Epitympano-mastoid operation, first stage.

outer attic wall, and removal of the malleus incus and tympanic membrane or of the remains of these structures which have escaped destruction by disease or injury (Stacke)

As a sound general rule the radical operation is only justifiable in place of Schwartze s when other means of arresting suppuration in the

* See p. 1[illegible] for notes on anatomy.

tympanum including the operations for overcoming infection of nose nasal sinuses and naso-pharynx and tonsillectomy have failed or are not indicated and when useful hearing is already permanently lost

In acute or recent otitis media it is not right to perform the radical operation in preference to Schwartze s unless there is *unmistakable* objective evidence that the labyrinth is invaded and that the patient s life is in imminent jeopardy

Cases of otitis media with infection of the sigmoid sinus have recovered completely after Schwartze s operation and drainage of the sigmoid sinus without recourse to the radical operation A child with tuberculosis of the lateral sinus recovered with no recurrence of tuberculosis or of middle-ear disease. The perforation of the tympanic

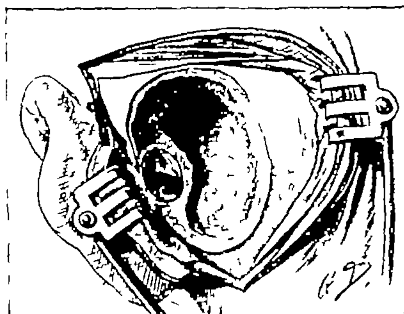


Fig. 643 —Epitympano-mastoid operation, second stage.

membrane healed and hearing was little short of normal which would have been impossible had the radical operation been performed Similarly satisfactory results are repeatedly encountered in cases of recurrent and prolonged suppuration It is also possible to avoid the *radical* mastoid operation in *acute* otitis media complicated by brain abscess and certain forms of leptomeningitis provided the mastoid and abscess are drained The use of penicillin and the sulpha group of drugs has undoubtedly proved valuable in the management of these cases both in cleansing the cavity and in diminishing recurrence and complications.

Technique. **First stage** completion of Schwartze s operation —The operator completes that part of the mastoid operation which involves removal of the mastoid cortex (*see* p 1581)

Second stage exposure and removal of osseous meatal wall —The self retaining retractor is opened out as the cuto-cartilaginous meatus

is detached The chief assistant with gauze strips or small wool swabs absorbs any blood which obscures the osseous meatus and the operator removes the posterior wall with gouge and hammer in

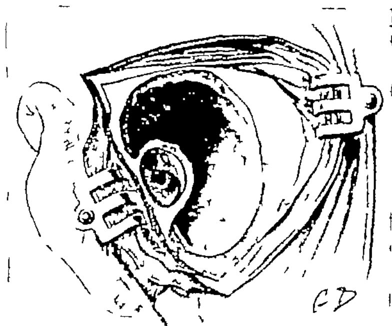


Fig 624.—Epitympano-mastoid operation, third stage.

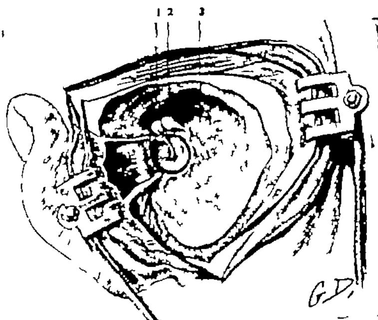


Fig 625 —Epitympano-mastoid operation, fourth stage.
1 Malleus 2, incus ; 3, eminence formed by external semi-circular canal.

order to display the bony bridge which arches over the upper attachment of the tympanic membrane A rectangular seeker may be passed *from above over the bridge into the aditus and attic* to enable the surgeon to determine the dimensions of the outer attic wall.

Third stage removal of outer wall of attic—This can be removed with three cuts with the gouge A small shallow gouge is selected (Fig 614 4) The first cut is parallel with the tympanic ring the second and third are respectively in front of and behind the malleus and almost radial to the tympanic ring These three cuts should isolate a small wedge-shaped fragment of bone which is picked out with forceps The aditus and attic now in view are exposed more freely by chipping away surrounding ledges and overhanging bone The surgeon will cut only what he can see and this will depend considerably upon his assistant s control of the oozing which otherwise would obscure the field An electro-motor suction apparatus is of great service in clearing the field of blood.

It is at this stage that the facial nerve is especially endangered and the greatest care must be taken to avoid injuring it

Fourth stage removal of ossicles, etc.—The incus and malleus or their remains are picked out with forceps With a small curette the operator removes the bloodclot granulations and cholesteatomatous epithelial débris which may be present and in doing so must beware of damage especially to the facial nerve the stapes the jugular bulb and the internal carotid artery These four structures have been injured at various times Fatal leptomeningitis following operations on the tympanum has been caused by dislocation of the stapes and labyrinthitis and it is an important rule never to curette *towards* the inner tympanic wall.

In two out of three cases of *very chronic* middle-ear disease no incus can be discovered and the head of the malleus is then generally eroded Not very rarely the malleus has completely disappeared. In these cases of diseased ossicles the surgeon has no cause for regret at having performed the radical operation but it occasionally happens that the incus and malleus after extraction are found to be absolutely normal in themselves though surrounded by granulations or swollen mucosa As there appear to be no very certain means of distinguishing these cases a conservative course is recommended for it will generally be a cause for misgiving when the surgeon finds that the ossicles and their articulations are unaffected He should feel concerned that nothing short of their removal had enabled him to discover the absence of destructive osteitis or arthritis and it is certainly worth the closest attention to seek some definite evidence of ossicular destruction before exposing or removing the auditory ossicles or running the risk of breaking an intact ossicular chain To this end the hearing test with Bezold Edelmann or similar forks is of practical value The radical mastoid operation is contra indicated when hearing is retained for low tones i e below 86 and 55 double vibrations per second

In a case open to doubt even where hearing is very defective it is certainly permissible to watch the effect of Schwartze s operation before advising conversion to the epitympanic operation or to the radical operation. Where tympanic suppuration persists in spite

of satisfactory mastoid drainage and freedom of the nose and pharynx from infection and when hearing is beyond hope of recovery the surgeon can seldom advocate conservation of the tympanum.

Figs. 622–625 illustrate the principal stages of the epitympano-mastoid operation which is applicable to cases of chronic disease of the antral region unassociated with gross destruction of the drum membrane and ossicles.*

Fifth stage plastic stage and provision for drainage.—Whereas the cavity formed in Schwartze s operation is drained through the primary skin incision some modified system of drainage is introduced in the radical mastoid operation

In the radical operation without intracranial involvement complete closure of the postaural incision is now the rule though this was not so formerly As Charles Ballance pointed out in his original paper over fifty years ago it is an advantage to divide the posterior meatal wall and throw the mastoid and tympanic cavities and external meatus into one common compartment

This enlargement of the meatus is in no sense an essential part of the radical operation though almost universally practised. A similar procedure—namely section of the posterior meatal wall with consequent expansion of the meatus—can be applied to Schwartze s operation as introduced by Küster and adopted by other aural surgeons (e g Heath s operation)

Section of the meatal wall and formation of a flap of skin which is turned aside *is an expedient to render the mastoid-operation* cavity accessible to inspection from the external auditory meatus it also hastens the growth of epithelium lining the cavity It is obvious that no flap can be fashioned from the meatus or concha alone to clothe the entire tympano-mastoid cavity an up- or down turned flap will cover only a portion of the surface of the operation cavity the rest must heal by second intention—the formation of granulations followed by epidermatization often a slow process unless skin-grafts be applied (*see* p 1589)

In recent years improved means of magnification originally designed for use during the operation of fenestration for otosclerosis and the greatly improved drills used for this procedure enables one to ascertain whether ossicular disease necessitating removal of incus and malleus is present The more detailed clearance of attic and periattic disease possible under high magnification enables one to leave the ossicles and restore a measure of hearing whilst eradicating the disease or at least giving access to it so that subsequent antibiotic treatment can reach the infected area.

The transmeatal approach to these structures has been extensively used, and whilst there are some who believe the meatus should not be

* The cortical and radical mastoid operation wounds should either be "Bipped" or treated with penicillin and sulphanilamide powder after irrigation. The value of penicillin and sulpha drugs as prophylactic after operation for chronic mastoid infections should be emphasized, otherwise the undoubted truth of the statement that these agents are of little avail in chronic infections may encourage neglect of their prophylactic value. The local application of penicillin and sulpha drugs has not been found to be of great service except as supplementary to their systemic administration.

incised and stretched there is much to be said for the end-on approach to the tympanic structures which this incision provides The familiar orientation makes anatomical recognition easy and in cases in which skiagrams show the mastoid to be acellular much needless removal of the solid bone of the mastoid buttress is avoided

No hard and fast rule can be made and surgeons should be familiar with both the transmeatal and the post auricular approach for use in appropriate cases. The wide unsightly meatal opening following excision of the conchal cartilage is seldom required nowadays.

The local application in these cavities of the more recently introduced antibiotics—Chloramphenicol, Aureomycin Terramycin—has proved successful in many chronic cases provided surgery has rendered the infected parts wholly accessible to these agents Subsequent healing and epithelialization are often more rapid than formerly

The meato-conchal flap —It matters little whether the meato-conchal flap be turned upwards or downwards Much depends on the size and shape of the mastoid cavity which has been made

The up-turned flap —The blade of the narrow scalpel is introduced into the meatus cutting edge downwards and an incision is carried through the skin along the floor as far outwards as the concha it then sweeps upwards across the concha as far as the crus of the helix above the meatus The size of the new formed meatus depends upon how far the incision is carried into the concha and crus Usually $\frac{1}{8}$ in behind and concentric with the posterior margin of the meatus will give a sufficiently large opening without producing an unsightly enlargement Care should be taken to prevent stenosis which sometimes results from removing too little cartilage from the concha

The section forms a meatal flap of skin and cartilage the latter being dissected out and detached while the pinna is held forwards. Only skin need be preserved and this should be thin so as to lie smoothly against the roof of the operation cavity A catgut suture or two is sometimes necessary to secure the outer corner of the flap in position Branches of the postauricular artery are divided and will generally require ligaturing

The down-turned flap —Instead of dividing the floor of the meatus the surgeon may make the incision along the roof thence into the concha and downwards to the lower outlet of the meatus The skin flap is freed from the fibro-cartilage as before and the thin layer of skin turned downwards instead of upwards No suture is required and sometimes the postauricular artery is avoided

Some surgeons prefer to make the incision along the posterior meatal wall with a T incision in the concha two narrow flaps are then up- and down turned The device appears to be devoid of any essential advantage.

Thiersch skin grafts.—It was to hasten and complete this epidermatization that Ballance introduced the application of Thiersch skin-grafts for cases of radical mastoid operation.* A period of ten

* *Trans. Med.-Chir. Soc. Lond.*, 1900, lxxx, 2.

days or so was allowed to elapse between the radical operation and the application of the graft which is now introduced as a routine at the time of the radical operation

Contra indications to graft —Should some intracranial complication such as extradural abscess lateral-sinus infection or brain abscess be discovered or the labyrinth be involved the application of the graft is usually omitted or postponed

Technique of Thiersch grafts (*see also* p 1952) —The skin-graft for the mastoid is usually taken with a razor from the inner surface of the thigh or from the upper extremity The razor should have a *straight* edge. The graft should be about 3 in. by 2 in and free from button-holes. Different methods have been employed to spread the graft after introducing it into the mastoid cavity Ballance s method is well known he employed a suction apparatus aspirating the blood which separates the graft from the granulation surface Other surgeons prefer to manipulate the graft in position with forceps and directors and apply small pledgets to keep it temporarily in place Some employ a pleated gauze strip or wick of coarse cotton strands on which the graft is spread and the plug is introduced into the cavity *en bloc* The narrowest single layer ribbon gauze or wick of cotton strands should be impregnated with Bipp paste to avoid the fœtor otherwise associated with skin-grafts in radical mastoid operation cavities An undoubted advantage of Bipped cotton wicks is that they can with care be withdrawn one by one so as to avoid pain in after-dressings. The postaural incision is then closed with three or four separate fishing-gut or catgut sutures or Michel clips Dry dressings are applied and secured with a narrow 2-in occipito-frontal bandage

The graft is of course quite uncalled for in Schwartze s operation where postaural tube drainage is employed without section or enlargement of the meatus and it is hardly required in Küster s operation for *acute* otitis media but when a meato-conchal flap has been cut as in Küster s modification of Schwartze s operation for *chronic* disease a graft may be applied

After-treatment.—Absolute uniformity in after treatment cannot be expected. Petroleum jelly dressings are painlessly removed.

The outer dressing may be removed in twenty four hours and a little of the packing loosened and withdrawn. Each day three or four inches more or less of packing or several cotton strands are withdrawn until by the end of the fifth or sixth day—possibly sooner—all packing has been removed from the cavity No fresh packing is introduced during the first ten days

In the second week there is generally more discharge than in the first and it is then often advisable to syringe the cavity morning and evening with normal saline Care is necessary to see that the fluid is approximately at the body temperature because after the radical operation the labyrinth is more exposed to thermal changes with consequent giddiness and often sickness and faintness.

By the third week all shreds of skin-graft have generally been washed away or removed but there may be granulations here and there If the latter become very soft and œdematous it is sometimes advisable to insert ribbon gauze packing changing it daily If the granulations are exuberant at the cut edge of the concha or of the meatal incision the application of chromic acid fused on a silver probe is recommended to prevent stenosis of the newly formed meatus

The ultimate success of an operation often depends upon the care with which the surgeon controls the overgrowth of granulation tissue Only too frequently a patient on whom a mastoid operation has been perfectly performed has been lost sight of until the whole cavity has become *filled* with granulations and synechiæ all because precautions to limit the growth of redundant granulations during the first few weeks were omitted

The patient can usually be allowed up by the fifth day and may go out of doors in suitable climates after the twelfth day Hospital patients usually become out patients in the third week With regular syringing the cavity generally heals completely in six to eight weeks In a very few exceptional cases cavities have become dry within two weeks and have remained dry and healed perfectly On the other hand some cases are very intractable and epithelialization is incomplete even after several months even though all cells and caries have been eradicated Such cases raise a suspicion of overlooked foci of infection the most frequent being some form of postnasal catarrh perhaps an obscure sphenoidal-sinus infection

It is interesting to observe the effect on suppuration in the ear of freeing the nose and pharynx from infection and the surgeon should constantly keep the upper air passages under his observation if he is successfully to counter persistent aural discharges after mastoid operations He will be wise for instance—to take a common example—to reverse the former practice of postponing the removal of the tonsils till the ear ceases to discharge except in cases of emergency

OPERATION ON THE INTRACRANIAL SINUSES FOR INFECTIONS OF OTITIC ORIGIN

The operation for infective thrombosis had been proposed though not practised in Germany and it was reserved to Sir William Arbuthnot Lane* and Sir Charles Ballance† some ten years later to be the first surgeons to operate successfully for this condition In their 14 cases there were 9 recoveries the previous mortality having been practically 100 per cent The technique is now such that the destiny of the patient may be said to depend primarily upon the early and accurate recognition of the disease and secondarily upon prompt and timely surgical intervention. Physicians and medical practitioners called to cases of acute or chronic ear disease are more than justified in thinking

* Clinical Society of London, April, 1889

† Medical Society of London, March, 1890. "On removal of pyæmic thrombi from the lateral sinus, *Lancet*, May 17 and 24, 1890, i, 1067 1114 (full paper with bibliography).

of the probable implication of the intracranial sinuses the first moment the patient s temperature runs high

Pathological considerations —The following classification comprises the usual and various complications which arise from intravenous infection due to otitis media

(1) Septicæmia independent of thrombosis of the intracranial venous sinuses or internal jugular vein.
(2) Thrombosis of the sinuses and/or jugular vein—
 (*a*) With neither local intravenous nor systemic infection.
 (*b*) With local but not systemic infection
 (*c*) With local and systemic infection e g
  Endocarditis
  Pneumonia.
  Thoracic empyema
  Abdominal visceral infection
  Suppurative arthritis
 (*d*) With local infection and cerebellar abscess.
 (*e*) With local infection leptomeningitis and encephalitis.
 (*f*) With local infection and cavernous-sinus thrombosis.

Septicæmia and Sinus Thrombosis

Although septicæmia occasionally occurs in acute otitis media without manifest signs of any localized infections of the great venous channels a more circumspect examination of the adjacent sinus and jugular bulb will sometimes reveal a localized area of endophlebitis, which certainly antedated the fatal systemic infection. Generally a coagulum of cells and fibrin from the blood-stream forms and adheres to the inner wall of the sinus at the seat of the attack. Its function is evidently to form a barrier When this succeeds and organisms invade neither blood-stream nor mural clot the latter becomes organized *and blends with the sinus wall and no clinical manifestations* are observed If virulent organisms raid the blood-stream before a thrombus forms or portions of the infected thrombus become detached the clinical picture of septicæmia at once begins. When the adherent coagulum vigorously resists the attack, it is reinforced by more and more fibrin and cells hastily precipitated by the passing stream the new clot adheres to and surrounds the first line barrier and as this yields to the infection so the thrombus grows and extends up and down and around the vessel-wall at last the whole stream becomes blocked by this mass which may reach up to the longitudinal sinus and down to the right chambers of the heart

But before the venous channel is blocked to this extent the first formed clot has completely succumbed become disorganized, disintegrated into a necrotic and purulent state it is now yellowish green with some particles quite black. At this stage the clinical picture may still be one of a localized infection severe as it is with moderate remittent pyrexia. Should the outer wall of the sinus

slough away and the purulent remnants of the clot escape externally the systemic circulation may be saved with the sacrifice of the venous channel alone.

But during the earlier stage of the process particles of infected fibrin may become detached and whirled along in the blood-stream setting up metastatic foci in heart or lungs or infecting the abdominal viscera and more remote parts of the body Then is it that the patient has rigors with great intermissions of temperature and the manifestations of metastasia may become more evident than the original focus of infection Endocarditis pericarditis pneumonia thoracic empyema abdominal signs closely resembling those of typhoid fever or suppurating arthritis may predominate A metastatic abscess in the brain may complicate the clinical picture

Apart from metastasia the original infection within the sinus may penetrate its inner wall causing a localized intradural or intracerebellar

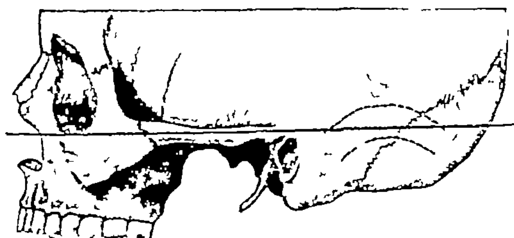


Fig 626 —Lateral aspect of skull to show infraorbital zygomatic plane (indicated by horizontal line— Frankfort Line ") and relation to lateral sinus, the position of which varies between the dotted lines. This is considered a better guide than Reid s base line

abscess Or the sepsis may spread either along the tentorial venous tributaries leading to widespread purulent pia-arachnoiditis and encephalitis or along the petrosal tributaries implicating the cavernous sinus the ophthalmic veins and the facial veins

So long as the infection is confined to the sigmoid sinus there is no characteristic symptom of its location but there is always at least moderate *pyrexia* which is a danger signal in otitis media It is unnecessarily risky to watch until the temperature chart shows daily excursions of 4 to 8 F often with *rigors* which have been generally regarded as pathognomonic of sinus thrombosis For by this time the case is already one of infective metastasia or septicæmia

When pyrexia cannot be completely explained by some other disease than that of the ear the safest course is to expose the infective focus and adjacent sinus-wall.

Having found the seat of infection the surgeon has two definite objectives before him

(1) The removal of all septic matter in the bone and adjacent venous channel

(2) Maintenance or establishment of permanent barriers between that part of the venous channel involved and the general systemic circulation

To achieve the latter it may be necessary to ligature the internal jugular vein

In the course of the mastoid operation for *acute* otitis media the disclosure of an unexpected extradural perisinus abscess immediately raises the suspicion of possible thrombosis

If the pyrexia and general state of the patient can be explained by the extradural abscess alone the surgeon is justified in waiting for a day or two before deciding whether or not to explore the sinus Red granulations on the sinus wall generally indicate a lively process of local resistance but a dark or greenish hue indicates that the sinus-wall should be laid open and explored without waiting for clinical evidence of sinus infection

If the pyrexia does not recede within forty-eight hours of the mastoid operation when granulations over the sinus wall have been seen even if there be no rigor the wound should be *re-opened* and the sinus re-exposed and laid open by incision with a scalpel or if there has been a rigor or two or sudden rise of temperature to 103 or 104 F alone it may be justifiable to explore and to tie the internal jugular vein in the first place before proceeding to open the sinus the objects being (1) to *confirm the diagnosis of thrombosis* (2) *to arrest particles* of detached thrombus due to manipulation of the sinus

Until considerable experience has been attained it is safer always to tie the vein In the complete absence of signs of systemic metastasia the operator need not tie the vein if the thrombus does not reach the jugular bulb Experience will help him to decide when he need not do so but it is safe to say that he will not regret having ligatured the vein.

These cases though rare still occur when chronic disease exists with organisms insensitive to antibiotics

Technique of operation on the lateral sinus.—The patient having been anæsthetized and the field of operation on the head and neck shaved and prepared with all customary aseptic precautions the *operator stands on* the side to be operated upon with his assistant at the end of the table and the anæsthetist on the opposite side

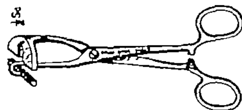


Fig 627 —Sargent s T forceps.

The mastoid operation is performed as *described at p 1529* To expose the lateral sinus it is necessary to divide the scalp and pericranium from the middle of the original mastoid incision backwards along the superior curved line of the occipital bone.

The squamo-parieto-mastoid sutures are exposed with the periosteal separator bleeding from vessels in the scalp is arrested with Spencer Wells or with T forceps (Sargent s) (Fig 627) and the retractors introduced The bone can now be removed with ¾ in gouge and hammer in thin flakes along the course of the lateral sinus and sigmoid sinus When the dura mater is exposed the cranial opening is enlarged with bone-cutting forceps (Fig 628) to expose two-thirds of the lateral sinus in a back ward direction and the superior genu inferior genu and transverse portions of the sigmoid sinus are exposed towards the jugular foramen

Before opening the sinus it is advisable to anticipate bleeding and exert pressure on its outer wall by introducing Bipped gauze plugging

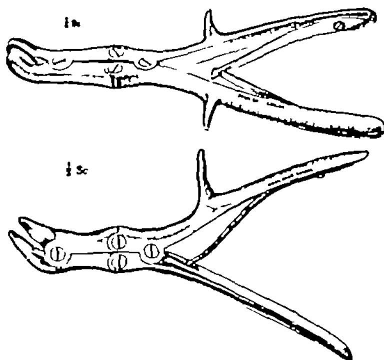


Fig 628 —Double lever craniotomy forceps.

between the adjacent unexposed portion of the sinus and the occipital bone. The sinus having been prepared for exploration the thickened or discoloured part of the wall is cautiously incised using first a scalpel then scissors to open a length of the sinus The clot can be picked out with forceps in many cases in some it is removed only with the aid of a curette Suction with the electro-motor pump is also effective in removing pus débris and clot

When the terminal part of the clot is withdrawn from the occipital end any blood escaping is much less than if preliminary gauze plugging were omitted and is the more easily controlled by temporary digital pressure When this is not adequate to stop the flow a small gauze strip must be introduced quickly on to or even into the sinus itself or a piece of muscle or a small fascial sheet can be applied to the sinus wound and packed in place with Bipped gauze or cotton wick

The advantage of using Bipped gauze is that it can safely be left undisturbed for 7 or 8 days Hæmorrhage from the sinus above the clot being now under control the entire outer wall of the sinus is excised with curved scissors as far as its entrance to the jugular bulb Moderately free hæmorrhage from the jugular end may be taken to indicate that the jugular bulb is not occluded

Profuse bleeding from this end rarely occurs and is easily arrested by packing Should pus and débris be found to ooze up from the jugular end of the transverse sinus the internal jugular vein must be exposed ligatured opened and drained

The upper two-thirds of the mastoid wound over the lateral sinus may be sutured allowing the ends of the Bipped packing to protrude The packing is gradually withdrawn inch by inch during the subsequent eight days when the last piece which compressed the sinus, comes safely away Care is taken to pleat the gauze at the time of insertion and to leave the end projecting in such a manner as shall ensure easy and painless removal. It is not safe to remove the last piece of plugging before the eighth day

Special points in ligaturing the internal jugular vein for sinus infections.—The skin of the neck and upper front of the chest is prepared as for other operations and a narrow sand bag is placed beneath the lower part of the neck and shoulders The head wound is temporarily covered with dressings and the internal jugular vein is exposed through an incision not less than three inches long starting at the angle of the jaw and running parallel with the anterior border of the sterno-mastoid muscle In several cases a curved horizontal incision about the level of the hyoid bone has given ample access to the vein and has the advantage of leaving a less noticeable scar The internal jugular vein is traced upwards beneath the parotid gland and subsequently downwards towards the subclavian vein when necessary Probably some enlarged lymphatic glands will be encountered before the vein can be found and they may have to be removed to isolate the vein. Generally the largest tributary to the internal jugular is the common facial vein

The internal jugular vein will often be found collapsed Two ligatures are applied and the vein divided between them Its upper portion is freed towards the skull all tributaries being separated and ligatured *en route* If the vein feels thickened it may contain clot and must be handled with extreme care until securely ligatured on the cardiac side of the clot.

The cephalic end of the vein is opened and the clot extracted a small curette being introduced up the vein as high as the jugular bulb if necessary The vein itself may then serve as a drainage-tube by being secured to the uppermost end of the skin incision as Alexander and Ballance advocated

The cervical wound is now closed a drainage-tube being provided at the lower or outer end and dressings applied to the neck.

The operation advocated by Grunerts who exposed the bulb in direct continuity with the transverse sinus and jugular vein is seldom justified

The radical mastoid operation —No mention has been made of the radical mastoid operation in lateral sinus infection We are dealing with infective sinus thrombosis in primary *acute* otitis media There is so far no indication for destroying the tympanic structures and we are anticipating recovery of the patient with complete return of hearing

The more frequent occurrence of infective thrombosis in the course of *chronic* otitis media will be referred to later but so far as the operations on the venous channels are concerned the procedure is the same in both cases the radical mastoid operation would be performed not because the venous sinus is involved but because of the changes wrought in the tympanum by chronic disease.

INTERNAL EAR OPERATIONS ON THE LABYRINTH

LABYRINTHITIS

Although operations on the labyrinth belong to a special branch of surgery it is important that the general surgeon should be familiar with the conditions for which they should or should not be undertaken

Vertigo and vomiting in a patient suffering from otitis media, whether acute or chronic should call for immediate investigation to ascertain whether the giddiness is due to infective invasions of the labyrinth or merely to congestive pressure or other less important but common causes of temporary labyrinthine disturbances without actual invasion or destruction of the internal ear itself The frequency and rapidity with which leptomeningitis follows infective labyrinthitis and the knowledge that this form of meningitis can be prevented or arrested by immediate drainage of the labyrinth are sufficient reasons for dwelling upon the great importance of early and accurate recognition of this complication of middle-ear disease

When middle-ear suppuration is present *vertigo reeling gait* and *vomiting* associated with *nystagmus* may be due in order of frequency (1) to disturbances in labyrinthine function caused by pressure or congestive changes in the middle ear which interfere through the fenestræ with the labyrinth pressure without destroying the neuro-epithelium (2) to infection and acute inflammation and consequent destruction of the labyrinthine neuro-epithelium (panlabyrinthitis) (3) to gradual destruction of the osseous labyrinth and formation of a fistula of the external semicircular canal (4) to cerebellar abscess

In investigating such cases after otitis media has been diagnosed the surgeon decides whether panlabyrinthitis is present or not. In panlabyrinthitis the patient suffers from permanent absolute deafness as well as giddiness and nystagmus of prolonged but temporary duration Having made certain that the patient is absolutely deaf on

the affected side the examiner must ascertain whether the vestibular labyrinth has lost its normal sensibility to stimulation by applying the caloric or thermal test (Fig 629)

It is important to remember that there are other forms of vertigo and other causes of headache in ear diseases besides actual infection of the labyrinth and that the diagnosis of labyrinthine infection must not be made unless the caloric tests have been carefully applied, and definite negative reactions obtained At the same time the surgeon must satisfy himself that polypi granulations and débris in the external or middle ear are not responsible for negative reactions by preventing the conduction of thermal influences to an intact labyrinth.

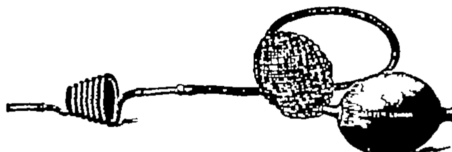


Fig 629 —Dundas Grant s apparatus for cold caloric test—a continuous current of cool air is blown into the external auditory meatus.

It is also most important to realize that inequality of pressure in the tympanum of either side will in certain circumstances cause nystagmus and vertigo in subjects with normal labyrinths

Acute otitis media is often accompanied in the initial stages by sensations of giddiness and sometimes by spontaneous nystagmus but normal reactions are evoked by the caloric tests. These symptoms soon disappear after myringotomy in cases where tympanic hyper tension is responsible

Diffuse labyrinthitis.—When the whole labyrinth is invaded spontaneous nystagmus will be observable when the eyes deviate towards the opposite side.

Localized labyrinthitis.—In cases of chronic middle-ear disease an erosion of the external semicircular canal sometimes takes place

The "fistula symptom."—The classical sign of labyrinthine fistula is evoked by sudden but gentle pressure applied to the meatus The eyes jerk horizontally to and fro the movement ceasing in a few seconds to re-appear every time the compression is re-applied The fistula symptom ceases directly the membranous labyrinth becomes destroyed

Labyrinthine fistulæ which give rise to no special symptoms immediately before the operation may be unexpectedly discovered in the course of a mastoid operation and it is important to know whether the fistula should be opened up and explored or left alone Any

unsuspected fistula discovered in the course of a radical mastoid operation should not be opened up unless the hearing and caloric tests yield negative reactions

Extirpation of the labyrinth.—*Partial* or *inferior vestibulotomy* consists in opening the vestibule from the tympanum below the *geniculate ganglion of the facial nerve* (Fig 630) Its object is to effect drainage of the cavity of the labyrinth and to remove the membranous contents The cochlea would be necessarily involved and useful hearing already lost

The more *complete* or ' *double* ' *vestibulotomy* combines with inferior vestibulotomy a counter-opening above and behind the second part of

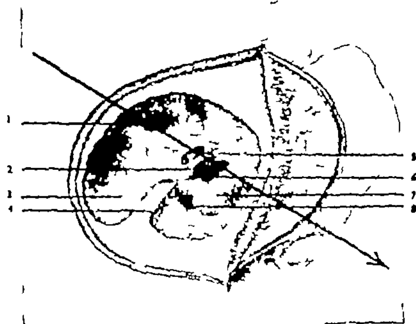


Fig 630 —Vestibulotomy first stage.

1 Inner wall of antrum ; 2, Fallopian aqueduct 3, floor of mastoid-operation cavity 4 posterior wall of osseous meatus 5, external semicircular canal 6, fenestra ovalis 7, promontory of cochlea 8, fenestra rotunda The arrow indicates an imaginary line which crosses in succession the antrum, external semicircular canal, facial nerve fenestra ovalis, cochlear promontory and Eustachian tube.

the facial nerve (Fig 631) This counter-opening is made into the external *semicircular canal either at the site of an existing fistula or* else through an artificial opening made by removing the eminentia arcuata externa *with the gouge and following* along the external crus of the *semicircular canal into its ampulla* thence by working upwards the ampulla *of the superior* semicircular canal is opened and the angular projection of dense bone in the posterior part of the roof of the vestibule is clipped off There is great danger of injuring the facial nerve and to guard against this accident the surgeon must be absolutely familiar with its topography and accustomed to the use of small gouges and hammer A burr is not generally recommended

In performing these difficult operations the surgeon depends largely on uninterrupted illumination and careful and experienced assistance. Zeiss operating lenses may be useful in some cases but require regular practice. With high magnification modern burrs as for fenestration are preferred to gouges in operations on the vestibule.

Technique of operations on the labyrinth. (*See* Fig 632) **Stage 1** —This consists of the radical mastoid operation.

Stage 2 consists in opening the vestibule below the facial nerve with a fine cutting drill Formerly a small gouge was selected and inserted in the pelvis ovalis By repeated slight taps with a hammer the

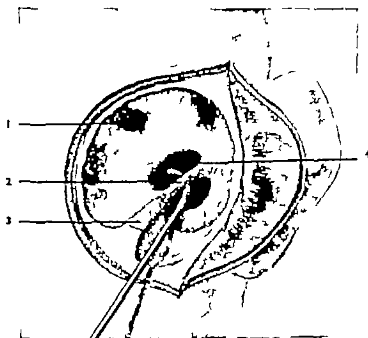


Fig 631 —Vestibulotomy second stage.

1 Inner wall of antrum 2, seventh nerve; 3, base of posterior meatal wall; 4, opening into vestibule above facial nerve through external semicircular canal. The hook is passing into the vestibule around the medial side of the seventh nerve

gouge was successively rotated until the first crescentic cut extended into a circle enclosing the whole of the outer wall of the vestibule below the geniculate ganglion of the facial nerve With the aid of seeker and curette the encircled fragment of bone is removed and the lowest whorl of the cochlea and floor of the vestibule are exposed and the foramen rotundum is destroyed. Those accustomed to use operating lenses prefer fine cutting drills for these extremely delicate operations.

Stage 3—In acute labyrinthitis the membranous labyrinth often separates in one mass of intensely hyperæmic membranous tissue. Bacteriologically it will be found to be swarming with streptococci or other organisms Unless it is intended to explore the internal auditory meatus it is not advisable to curette the antero-internal wall of the

vestibule or the base of the modiolus of the cochlea though the internal meatus can be opened deliberately in certain cases to allow cerebro-spinal fluid to escape (*see* below)

Extirpation of the cochlea—This operation is undertaken as an extension of vestibulotomy in cases of tuberculosis or of malignant disease The proximity of the internal carotid artery immediately beneath and in front of the outer coil of the cochlea must not be forgotten

Leptomeningitis secondary to Labyrinthitis

Leptomeningitis is the most fatal complication of otitis media though the use of penicillin both by systemic injection and intrathecal

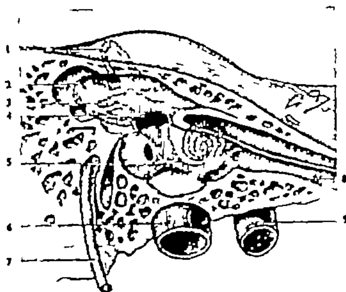


Fig 632—Lateral vertical section of temporal bone through tympanum, to show relative position of labyrinth.

1 Superior semi-circular canal 2, posterior ditto 3, external ditto; 4, vestibule; 5, cochlea 6, internal jugular vein 7 facial nerve 8, Eustachian tube; 9 internal carotid artery

administration has created a much more favourable outlook Patients in whom pus in the labyrinth is overlooked often die of leptomeningitis and unless at the autopsy the labyrinth is deliberately examined no one may be aware of this path of infection from the tympanum to the membranes of the brain Many cases of basal meningitis have been proved to be due to purulent labyrinthitis The only special operations for leptomeningitis considered here are translabyrinthine drainage and repeated lumbar puncture

Lumbar puncture.—In acute otitis media where an intracranial complication is suspected *exploratory lumbar puncture is frequently necessary* Fluid is withdrawn for bacteriological cytological and chemical examination It is also important to ascertain whether the cerebro-spinal fluid is under excessive pressure or not

When the cerebro-spinal fluid appears perfectly clear only sufficient fluid should be withdrawn in the first instance for examination purposes, but where it is turbid and under pressure it should be allowed to flow slowly until the pressure appears normal Sometimes—especially in cerebellar abscess—the withdrawal of even a few cubic centimetres of cerebro-spinal fluid is followed by arrest of breathing The surgeon must be prepared for this contingency which is an indication for immediate exploration of the cerebellum while artificial respiration is maintained

THE OPERATION OF FENESTRATION OF THE LABYRINTH FOR OTOSCLEROSIS

The surgical treatment of otosclerosis began in the later part of the nineteenth century and the names of Holmgren of Stockholm, and Sourdille of Nantes stand out the former for his courage and persistence in keeping the idea alive through a period of little success, and the latter for the conception of an open operation which allowed airborne sound waves to have direct access to the fenestra. But it was Lempert of New York, who in 1938 by the introduction of a one stage procedure really put the operation on a practical basis Since then, modifications and improvements have been introduced by Lempert and others notably Shambaugh of Chicago

Selection of cases for operation.—Although to begin with the deafness is purely conductive as the disease advances there is always an added perceptive element and there is obviously no value in bypassing a fixed stapes unless the cochlea is capable of an adequate response. As yet there is no test that gives an absolutely reliable indication of cochlea function and though it is easy to pick out the extremes the intermediate cases present some difficulty A clinical test the ability to hear really clearly with an aid is of great value. The final result must also depend on the degree of deafness since although occasionally an improvement of over forty decibels may occur the average gain after a successful operation is of the order of thirty decibels and it follows that with an initial deafness of seventy or eighty decibels though the gain may be great and the patient very likely satisfied, nevertheless hearing cannot be really satisfactory

Fig 683 A shows the audiogram of an ideal case Bone conduction is so good that the state of the nerve cannot be in doubt and a lift of even twenty decibels for the speech frequencies gives hearing which the patient will consider normal Fig 683 B shows an advanced case a deafness of some eighty five decibels and bone conduction depressed particularly for the high frequencies. Though occasionally such a case will do unexpectedly well the result is more usually as given in this audiogram Fig 683 C shows an intermediate case the deafness is severe and bone conduction far from normal but the result proves that the cochlea was not severely damaged

Having offered an assessment it must be made plain to the patient that there can be no guarantee that the most promising case may be a complete failure even to the extent of making the ear worse that

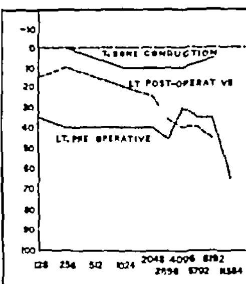


FIG. A

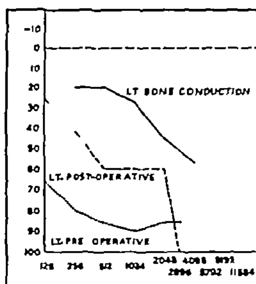


FIG. B

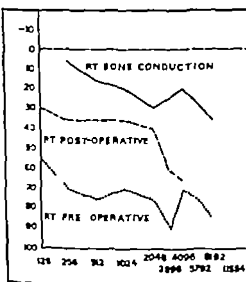


FIG. C

Fig 633 —Otosclerosis. Audiograms at different stages of the disease (see text). (*From Arch Middx. Hosp*)

immediate gains do not always last and that in the advanced case there is less than the average chance of even a limited success

As a conservative estimate of immediate results favourable and reasonably favourable cases may be offered a 70 per cent chance of a really good result a 20 per cent chance of a result varying between no change and a moderate improvement and a 10 per cent risk of the ear being made worse Deaf people are always desperately anxious to have something done and given the least encouragement nearly all would elect for operation It is therefore the duty of the surgeon to be doubly careful not to offer more than is justified.

This section considers brain abscess resulting from middle-ear disease it may take the form of (1) cerebellar abscess or (2) temporo-sphenoidal abscess (*See* also p 1505)

Cerebellar Abscess*

The close proximity of the petrous part of the temporal bone to the anterior surface of the cerebellar hemisphere permits infective processes from the mastoid antrum mastoid cells and internal ear to reach the cerebellum by direct paths of infection In the course of operations on the mastoid a track of infection may be found leading to an extra

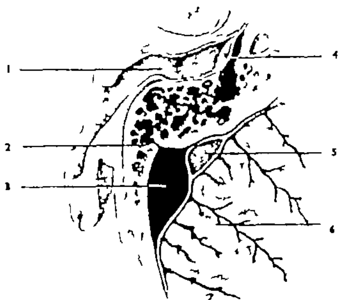


Fig 635 —Extradural abscess horizontal section of temporal bone through *external auditory meatus and mastoid cells.*

1 External auditory meatus 2, mastoid cells 3, extradural abscess 4, tympanum 5, sigmoid portion of lateral sinus 6, cerebellum.

dural abscess in the posterior cranial fossa or even to a cerebellar abscess when no obvious symptoms had been observed beforehand (Fig 635) Approximately one-third of the cases of cerebellar abscess are preceded by infection of the lateral sinus and when these complications co-exist the signs and symptoms due to invasion of the sinus are likely to obscure those due to cerebellar abscess (Fig 636) In one-third of the cases of cerebellar abscess from disease of the middle ear destruction of the labyrinth occurs before the brain is invaded The vertigo and vomiting caused by the labyrinth disease may have occurred weeks months or years before the formation of the abscess in the brain In the remaining one-third of the cases cerebellar abscess develops *independently* of lateral-sinus involvement (Fig 637)

* See also Chap XXVI, Operations on the Skull and Brain.

or of labyrinth infection The path of infection then leads from the antrum or adjacent cells into the posterior cranial fossa on the mesial or lateral side of the sigmoid sinus not infrequently an extradural abscess forms first on the posterior wall of the petrous below the superior petrosal sinus and generally bounded by the sigmoid sinus on the outer side Sometimes the whole sigmoid sinus is displaced from the sigmoid groove by the extradural abscess

The development of cerebellar abscess is generally protracted thus differing from labyrinthine invasions the onset of which is always

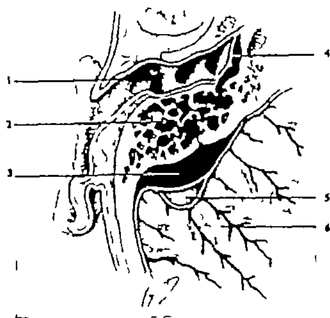


Fig 636 —Extradural abscess, subtentorial (horizontal section)

1 External auditory meatus; 2 mastoid cells 3, Extradural abscess anterior to sigmoid sinus, 4 tympanum 5 sigmoid sinus 6, cerebellum.

sudden Exploration of the brain for cerebellar abscess must be justified by definite data. The diagnosis is made by careful consideration of the general clinical features and the results of certain special signs and tests The history is often of great importance When in the course of middle-ear suppuration severe headache develops with rigidity of the cervical muscles in the suboccipital region the surgeon must consider abscess of the cerebellum amongst other possible causes There may be vomiting staggering gait and the general manifestations attributable to increased intracranial pressure The surgeon must beware of attempting to lower this pressure by lumbar puncture alone The neurological signs and symptoms associated with cerebellar inefficiency viz. asynergia hypermetria and hypotonia must be sought though they seldom occur simultaneously Reflex symptoms such as hiccough and

yawning are not infrequent in cerebellar abscess Ocular nystagmus is generally present while paralytic strabismus and œdema of the retina are also often though not always discovered Giddiness is not such an essential feature of cerebellar disease as it was formerly thought to be though it may be prominent for instance it occurs repeatedly in temporary disturbances of an intact labyrinth and also when the labyrinth is in process of dissolution generally as the result of invasion from the middle ear (*see* p 1547)

Cerebellar abscess occurs in acute as well as chronic otitis media. It is well to bear in mind the possibility that the infection of the

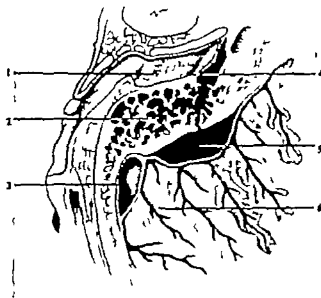


Fig 637 —Extradural abscess, subtentorial (horizontal section)

1 External auditory meatus; 2, mastoid cells; 3, sigmoid sinus; 4, tympanum; 5 extradural abscess mesial to sigmoid sinus; 6, cerebellum.

middle ear may have resolved so far as the tympanum is concerned after the infection has already passed on through the dura mater into the great horizontal fissure of the cerebellum. Here in turn the track may again resolve as the infection proceeds and finally the abscess may be found as it was in one of the author s *patients* in the posterior part of the cerebellar fossa.

Symptomatic diagnosis of cerebellar abscess.—**Deafness** may be that of the ordinary middle-ear type or it may be intense and absolute on the affected side Acute otitis and deafness may have passed off by *the time the patient develops signs of cerebellar abscess.*

Discharge from the ear —A trustworthy history of recent otitis media is very important There is not necessarily any discharge mastoid pain tenderness or swelling or any other abnormally *sensitive* area

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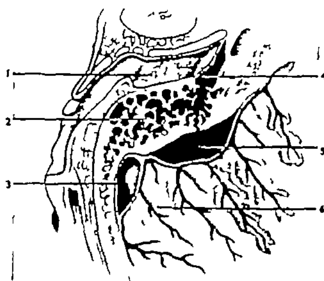


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but sometimes the affected side is decidedly tender especially in the suboccipital region

Headache—The headache is generally severe and referred to the frontal or occipital region At first it may last only a few minutes at a time but eventually becomes continuous The patient may have had attacks of severe headache and be free from pain at the moment of examination

Vomiting—Occasional vomiting is a common though not an essential symptom

Pyrexia.—Although general teaching emphasizes the association of *subnormal* temperature with abscess of the brain it should be borne in mind that abscess secondary to middle-ear disease is often accompanied by pyrexia. The temperature may be either a little above or a little below the normal Every now and then there may be a sudden rise or a sudden occasional transient fall A rigor is rare unless the sigmoid sinus is also involved.

Pulse rate—This is not necessarily slow it is often above normal it may be normal for days together and there may be sudden isolated falls

Head retraction.—Head retraction or resistance to forward flexion is almost invariably present particularly in the later stages

Kernig's sign is generally present The patient will often prefer to lie at full length or even stand erect to avoid a flexed forward position as in sitting

Rombergism, though often present may be absent even when the abscess is large

Nystagmus.—In the early and late stages there may be no nystagmus but the diagnosis of cerebellar abscess would seldom be justified in the continuous absence of this important sign. The nystagmus is usually but not invariably similar to that met with in other hemispherical lesions of the cerebellum. Spontaneous nystagmus was well marked on deviation of the eyes to the left when the head was erect (the patient had left-side cerebellar abscess) the rhythmic movement was concomitant and possessed considerable amplitude so that the nystagmus elicited when the eyes were directed to the left was quite obvious The period of movement of the eyeballs alternated regularly so that each rapid jerk towards the side of deviation was succeeded by a slower movement in the opposite direction On deviation of the visual axes to the right with the head erect no nystagmic movement was noticed at first but on closer inspection a very fine rhythmic nystagmus was observable the amplitude of movement being much less than that seen when the eyes were deviated towards the left the direction of movement on deviation to the right appeared to be purely horizontal with a distinctly alternating period the rapid jerk being towards the side of deviation In a day or two the nystagmus on deviation to the right became more easily recognized

and the direction of movement distinctly oblique and slightly rotatory (torsional) with a rapid jerk towards the side of deviation. *

Optic neuritis.—Œdema of the retina is valuable evidence of increased intracranial pressure but the absence of optic neuritis does not negative the diagnosis of abscess of the cerebellum.

Special neurological tests for cerebellar abscess.—**Asynergia,** as described by Babinski is characterized by a loss of the faculty of association of movements with a want of synchronization. Purposeful movements of the upper or lower extremities appear to be carried out rather slowly in comparison with those of the opposite limbs and are not only exaggerated (hypermetria) but appear to be wanting in smoothness. In purposeful movement of the whole limb individual joint movements appear detached and excessive.

Hypermetria.—The well known finger-to-nose test is an example of asynergia when resulting in exaggerated movement (hypermetria on the homolateral side) and is frequently noticed in cerebellar abscess. The cerebellar patient will overshoot the mark on the affected side whereas the healthy subject will carry out these movements correctly without difficulty with both arms.

Dysdiadokokinesia or difficulty in making alternate movements—another special example of asynergia—may be observed, for instance when the patient rapidly alternates pronation and supination of the forearm (on the side of the lesion).

In some normal right handed patients the left hand performs rapid pronation and supination awkwardly compared with the right. This may be very misleading if the fact is not borne in mind.

Hypotonia (homolateral muscular asthenia).—The patient may have a subjective sense of asthenia in the upper and lower extremities on the homolateral side without any definite paresis or paralysis. Homolateral hypotonia must not be confused with contralateral monoparesis due to a cerebral lesion.

Cerebellar catalepsy is sometimes, though rarely, found. There may be prolonged immobilization of the limbs in certain positions of static equilibrium; the phenomenon may be observed when the patient has become unconscious; a raised arm will remain elevated until passively replaced to the patient's side. †

Staggering gait.—When attempting to walk along a straight line with the eyes open the patient with cerebellar abscess may swerve away from the lesion; especially is this likely if the labyrinth of the affected side has been previously destroyed by disease. The patient may be conscious of walking with a wide base as if intoxicated although he may have no subjective sensations of giddiness. In pointing at a given object within reach, eyes closed, the hand or the foot errs towards the side of the lesion.

* From the report of a case by the author in *Proc. Roy. Soc. of Med.* (Otol. Sect.), 1909, ii, 4.
† *Proc. Roy. Soc. of Med.* (Otol. Sect.), [illegible]

Diagnostic lumbar puncture —Lumbar puncture is performed in these cases to ascertain the appearance and state of the cerebro-spinal fluid and to ascertain whether leptomeningitis has already set in Not more than 2 or 3 c c should be withdrawn for pathological tests When in the course of an operation for middle-ear disease there is reason to suspect some cerebellar complication and the patient stops breathing the surgeon must not abandon the operation but should relieve the intracranial pressure as rapidly as possible while his assistants are performing artificial respiration Cases of complete recovery from cerebellar abscess have been reported from time to time even though the patient ceased to breathe before the operation was commenced. In one such case artificial respiration was carried out for about three quarters of an hour while an abscess of the cerebellum was opened. Although the patient remained comatose for four days he eventually recovered and is still in robust health over twenty years later *

Technique of the operation. **Stage 1** **Mastoid operation** —Schwartze s operation (p 1529) is the first step

Two routes are now available for opening the cerebellar fossa (1) the mesial (2) the lateral in relation to the sigmoid sinus The com monest site for a cerebellar abscess is close to the anterior surface of the lateral lobe about the level of the mastoid antrum—that is to say below the plane of the superior border of the petrous

Stage 2 **Exposure of the dura mater of the posterior cranial fossa** — An incision of the scalp 3 or 4 in long is made along the superior curved line The pericranio-cervical muscles attached to the superior curved line and suboccipital region are detached with a periosteal separator and the branches of the deep occipital artery and of neigh-bouring vessels are picked up with pressure forceps Sometimes a mas toid accessory vein causes very troublesome bleeding though it is controllable by pressure with gauze or Horsley s wax A triangular area of bone is thus exposed the antero-superior angle corresponding to the region of the mastoid antrum the antero-inferior angle to the apex of the mastoid while the posterior angle is formed at the termina tion of the incision along the superior curved line In removing the bone different methods are adopted A broad gouge is preferable to the circular trephine The gouge is laid on in a plane almost parallel with the surface of bone so that long broad thin chips can be removed the whole of the outer table is thus sliced away Here and there the inner table will also be removed exposing the dura mater Small bone-forceps can then be inserted to enlarge such openings sufficiently to permit the introduction of the larger bone-forceps with which the inner table can be more rapidly cut away In a few minutes it is possible to expose an oval area 5 or 6 cm by 3 or 4 cm in diameter without injuring the dura mater

The area of the dura mater exposed may appear normal for the most part except where an extradural abscess is encountered The colour

* *Proc. Roy Soc. of Med.* (Otol. Sect.), 1923, xvi, 87

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and appearance of the membrane will be noted and any granulations carefully investigated to ascertain if they surround a fistula leading into the cerebellar abscess Such a fistula may be found either on the mesial side of the sigmoid sinus or on its external side or it may lead directly into or through the inner wall of a thrombosed sinus.

Stage 3 Opening the dura mater.—When possible it is desirable always to open a cerebellar abscess through the pathological route of infection that is generally through the anterior wall of the cerebellar fossa. But in cases where the tension in the posterior fossa is high it may be better to expose the cerebellum through the postero-inferior wall of the cerebellar fossa external to the sigmoid sinus especially when pulsations of the cerebellum cannot be seen or felt. The dura mater should be incised radially to permit free herniation of the cerebellum before the abscess in the brain is opened It is quite likely that in the circumstances the abscess will be found to be more accessible by this artificial route than by following the pathological route The gravest risks of cerebellar abscess are caused by absence of localized meningeal adhesions at the site of drainage Attempts have been made to induce adhesions to form by the application of say 10 per cent iodine in very small quantity to the edges of the incised dura mater

Drainage.—While it is difficult to dogmatize on such a subject as drainage of a brain abscess—for recovery after complete evacuation of the abscess by aspiration or otherwise sometimes ensues when no drain has been provided—rubber drainage-tubes are generally superior to gauze plugs or to tubes of glass silver or bone Two or more rubber tubes in parallel have proved most successful concentric metal tubes on the tracheotomy principle have yielded good results The tubes should be sutured to deep fascial fixed tissue *not* to the skin.

Dressings.—After partial closure of the wound by suture the cavity may be lightly filled with gauze lightly covered with outer dressings wool and bandage or cap

After treatment.—The treatment consists in daily dressings and attention to the drainage-tubes until the patient s condition and the state of the wound have improved sufficiently to allow complete closure by secondary suture—say about six weeks after the abscess has been opened and drained

Results.—Recovery took place in rather more than 60 per cent of cases of cerebellar abscess operated upon and there seems to be no reason why these figures should not be improved if greater accuracy in diagnosis is achieved so that fruitless exploration as well as undue delay may be avoided. Compared with successful operations for cerebral abscess which may leave some permanent mental or other defect recoveries from cerebellar abscess are usually much more complete leaving no deficiency mental or physical or cerebellar

Temporo-sphenoidal Abscess

When suppuration within the brain substance is due to otitis media it begins by direct extension of the infective processes from the temporal bone through the dura mater into that part of the brain cortex lying directly over the seat of infection (Fig 638)

In half the cases of temporo-sphenoidal abscess the outer surface of the dura mater is visibly diseased at the seat of infection being hyperemic granular and thickened and often coated with a layer of pus or lymph or else it is ulcerated or sloughing with a fistulous track leading directly through the dura into the temporo-sphenoidal lobe

Even where the outer surface of the dura mater directly over the origin of infection appears to be normal its inner surface generally becomes

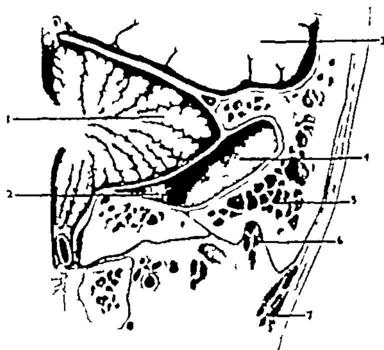


Fig 638 —Coronal section of temporal bone through mastoid process showing topography of mastoid cells to brain and sigmoid sinus.

1 Cerebellar hemisphere; 2 entrance to jugular bulb; 3, temporo-sphenoidal lobe; 4 sigmoid sinus 5, mastoid cells 6, posterior belly of digastric 7 sterno mastoid.

adherent to the pia arachnoid membranes and to the brain cortex at the site of invasion Moreover as a rule the floor of the abscess in the temporo-sphenoidal lobe is only a few millimetres from these adhesions (Fig 639)

Sometimes the presence and site of brain abscess may be revealed by erosions and destruction of the roof of the antrum and adjacent cells leading directly to the midcranial fossa seen in the course of a mastoid operation The more chronic the disease of the ear the greater the likelihood of cranial penetration (Fig 640)

Suppuration in the substance of the temporo-sphenoidal lobe may progress in several different ways For instance on the one hand

the infection may rapidly set up diffuse encephalitis around the abscess on the other the inflammatory process may remain strictly localized a dense capsule eventually forming in the walls of the abscess So thick may the walls become that the mass presents the appearance of a solid tumour until bisected Owing to the increased density the thickly encapsuled abscess may migrate perhaps under the influence of posture from the seat of its origin and be found situated in the fronto-parietal parietal or occipito-parietal region. This migration never occurs with thin walled abscesses

Sometimes an abscess with a thin membranous capsule will steadily enlarge at the expense of brain tissue without any surrounding extra

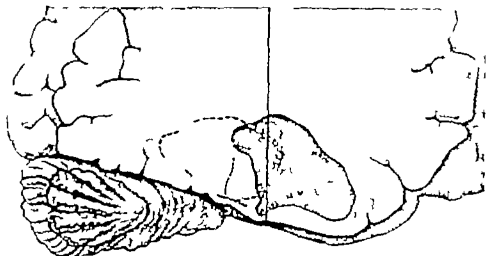


Fig 639—Temporo-sphenoidal abscess, vertical section, antero-posterior Vertical line indicates mid-coronal plane. Dotted lines indicate the usual sites of abscesses.

capsular infiltration or swelling In such cases the abscess may destroy practically the whole of the temporo-sphenoidal lobe extending back towards the occipital pole

A patient presented the characteristic signs of a cerebral tumour involving the uncinate lobe with defects of smell for two years before it was discovered to be due to a thickly encapsulated bilobed hourglass shaped abscess in the anterior and mesial part of the temporo-sphenoidal lobe

Though the classical symptoms of brain abscess are well known they are sometimes absent and the patient s fate is sealed before the diagnosis becomes clear owing to the abscess suddenly bursting into the lateral ventricles or penetrating the cortex of the brain and leaking into or flooding the intradural space The picture is then that of fulminating meningitis

The surgeon must approach the question whether there is an intra cranial infection from middle-ear disease with the knowledge that the decision is of supreme importance and not merely of clinical interest If he explores the brain simply because an abscess is suspected to be in

process of formation he will often fail to find one Furthermore there is reason to believe that premature explorations may cause an abscess to develop

Naturally a disease running such diverse courses will often present great difficulties in diagnosis

Symptomatic diagnosis of temporo-sphenoidal abscess.—As a rule the patient is under observation before the diagnosis of brain abscess can be definitely made He is obviously ill and has disease of the ear The existence or recent occurrence of tympanic suppuration is more important than the apparent extent of the ear disease The history of recent earache deafness tinnitus, with perhaps pyrexia following sore throat or rhinitis particularly in the course of influenza pneumonia or a specific fever is of unquestionable importance

Besides ear disease there are headache feelings of disturbed health loss of energy perhaps vomiting and pyrexia Nothing more may be

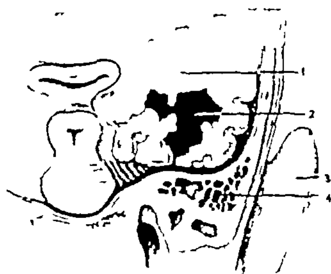


Fig. 640.—Coronal section of head, to show right-sided temporo-sphenoidal abscess due to middle-ear disease.

1 Temporo sphenoidal lobe 2, abscess cavity 3 pinna 4, mastoid cells

discovered for some time The pyrexia may have ceased or recur occasionally There may be isolated instances where the temperature is subnormal for a few hours The pulse-rate may be normal or slightly raised with an occasional and brief drop of 10 to 20 beats per minute

Eventually the classical cerebral syndrome headache vomiting and generally optic neuritis points to increased intradural tension

Headache.—This may be severe persistent and agonizing the patient may become almost maniacal unless relieved. Sometimes the pain is localized to one side or is a radiating generalized fronto-occipital pain In some cases there are more or less prolonged intermissions

Vomiting is not always present or frequent It is apt to occur on waking or moving

Optic neuritis usually does not develop until late compared with its earlier appearance in cerebellar abscess perhaps because the latter owing to its position may more easily cause distension of the cerebral ventricles Cushing drew attention to a degree of dilatation of the venules of the upper eyelid as being a fair index of the degree of stasis revealed by the ophthalmoscope.

Pulse and respiration are inclined to be slow when general intra dural tension rises

Stupor and torpor eventually develop

A convulsion or a rigor occurs occasionally

Before the onset of stupor or torpor the patient s mental alertness and activity have probably become affected. A want of accuracy in reasoning and judgment may be obvious to the patient himself his memory becomes capricious he lacks power of recognition discrimina tion and decision These interferences with the intellectual faculties are even more noticeable to his friends and can be demonstrated by testing his accuracy in reading spelling calculation and especially by laying objects before him to name

Word amnesia causing **pseudo-phasia** is of special importance in the localization of an abscess to the temporo-sphenoidal lobe of the left side in right handed individuals (the reverse of course in left handed persons) This inability to correlate ideas of objects with names of objects is discovered when a patient is shown numerous common articles such as a pencil a pen a penknife a pair of scissors a pin or a bunch of keys and is asked to name each in turn A few may be correctly named but if there is marked hesitation or inaccuracy this may be regarded as corroborative evidence of a left-side lesion of the temporo-sphenoidal lobe

Contralateral hemiplegia.—When a brain abscess is not diagnosed until it has led to hemiplegia the prognosis is more grave Convulsive twitchings of the limbs on the opposite side may precede paralysis

Increase of the deep reflexes indicates involvement of the cortical radiation or of the internal capsule

Successive (supranuclear) contralateral paralysis of the face arm and leg would indicate extension of the encephalitis upwards while rapid onset of paralysis of leg arm and then face point to extension in a mesial direction towards the internal capsule. Hemiplegia does not necessarily indicate that the abscess itself has reached the motor tract which may be affected by the surrounding œdema or by pressure and therefore may be temporary Besides hemiplegia there is contralateral hemi-anæsthesia which develops as the abscess extends laterally and backwards resulting in a *loss of sensation of the position of the limbs*

Ocular palsies.—Either or both sixth nerves may be affected and the third nerve on the same side is sometimes involved the pupil being dilated or fixed

Homonymous contralateral hemianopia is sometimes observed and is attributable to involvement of the lateral radiation fibres to the occipital lobes The pupils react to light when the rays impinge even

on the blind half of the retina alone Cushing drew attention to the frequency with which slight degrees of contralateral anopia are overlooked especially in the early stages when only the upper quadrant of the opposite visual field may be affected (quadrantic anopia)

Treatment.—In dealing with otitic cerebral abscess we may follow the teaching of Ballance who says The surgeon has no commission to trephine the skull in various situations according to surface measurements which on anatomical grounds would lead him to the surface of the lobe of the brain in which he has suspected an abscess In seeking an otitic brain abscess the complete mastoid operation should first be done and all disease in the bone followed to its limits this may conduct the surgeon directly to the abscess but *if not* he will have made up his mind from the symptoms whether to explore the temporo-sphenoidal lobe or the cerebellum

In carrying out the operation it is important (1) to open and drain the abscess without infecting the surrounding brain or intradural space This can be accomplished if the track of the abscess be discovered

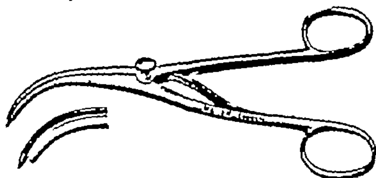


Fig 641 —West s forceps for opening track of brain abscess.

through adhesions of the dura mater to the brain Failing that (2) the abscess with its walls should be removed intact without opening it Cases in which the abscess track cannot be found will be considered later

The operation for temporo-sphenoidal abscess.—General and local preparation.—This is the same as for any extension of the mastoid operation (p 1620)

Instruments and equipment —The same instruments can be used to open the cranium as those required to perform the mastoid operation and should include craniotomy forceps In addition a ½ in trephine and a trocar and cannula may sometimes be required. Sargent s clamp forceps for the scalp are most useful to control hæmorrhage especially if a horseshoe flap is made A small silver teaspoon may be useful for encapsuled abscess.

Stage 1 Mastoid operation and removal of the tegmen —To remove the tegmen thoroughly so much of the squamous portion of the temporal bone is cut away with forceps as to make a wide and efficient opening into the cranium an extension upwards of the scalp-incision for about 3 in is generally sufficient if the parts are well retracted

Stage 2 Inspection of the dura mater.—While the assistant keeps the cavity dry the surgeon carefully looks for signs of external pachymeningitis He may find a fistula which leads directly upwards into the temporo-sphenoidal lobe

Stage 3. Exploration of the brain.—(*a*) If a sinus or fistula is present curved forceps such as those devised by West (Fig 641) can be inserted and the opening stretched sufficiently to allow pus to escape and enable the operator to introduce one or more rubber drainage-tubes into the abscess cavity

(*b*) There may be signs of pachymeningitis in the region of the tegmen without an actual sinus or fistula. A small incision must then be made across the centre of the visible area of diseased dura.

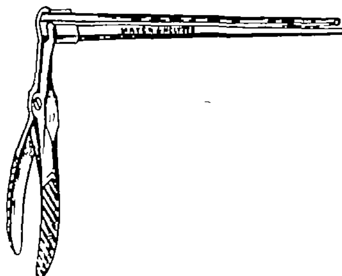


Fig 642 —Horsley s brain seeker

This incision is cautiously stretched open with the curved forceps When this procedure fails to open an abscess repeated punctures into the brain should not be made It is permissible to stretch the dural opening with a seeker (Fig 642) widely enough to permit the tip of the finger to be introduced The finger will detect any seat of resistance and form a guide to the position of an abscess or the operator may judge by means of a suitable probe (Cairns)

When a thickly encapsuled abscess is felt it may be possible to enucleate it intact

Stage 4 Enucleation of encapsuled abscess.—A small encapsuled abscess when located near the dura mater can be removed with a scoop or small teaspoon which Horsley used. When too large or located too far from the tegmen it can be removed through the lateral cortex

Absence of pachymeningitis externa.—In cases where the signs and symptoms of temporo-sphenoidal abscess are very evident, and yet no disease of the outer surface of the dura mater can be detected the

surgeon may have to expose the temporal lobe through a horseshoe incision of dura mater as for tumour of the brain If there is marked increased intracranial pressure or cessation of pulsation of the brain he should elevate the inferior part of the temporal lobe and seek for evidence of pachymeningitis interna If adhesions are visible from within the brain substance may be incised below through the dura mater opposite the adhesions instead of through the exposed cortex

Sometimes the abscess track cannot be found that is no pachymeningitis either external or internal can be discovered Confirmation of the diagnosis of temporo-sphenoidal abscess is justified when pulsation is absent in the part of the brain exposed or when the intracerebral tension is so high that the brain protrudes through the dural opening In the latter event the cut edge of the dura can be incised radially to allow the soft brain to herniate and mushroom and can be explored with curved forceps or even with the finger Sometimes a surprisingly large abscess is found The finger will serve as a guide for rubber drainage tubes which should be inserted and retained by sutures to the pericranium not to the skin

In circumstances such as these gauze well smeared with Bipp has proved useful A coil of gauze is wound around the protruding brain over which more layers of gauze are placed and retained with a bandage The *outer* dressings need not be disturbed for thirty-six to forty-eight hours they should then be renewed and the wound dressed daily Generally the less done to disturb the brain the better the results

If all goes well the swollen brain recedes sloughs are cast off new granulations form and in five or six weeks the wound may be ready for closure with sutures after undercutting and freeing the skin

CHAPTER XXVIII

EYE SURGERY

By H B STALLARD, M.B E

THE qualities of mind and heart which make a good eye surgeon are essentially those of the general surgeon with certain refinements of technique necessary for the minute precision work in a very small space. Good binocular vision absolute steadiness of the hands a fair measure of ambidexterity an equanimity which will endure the high tension involved in intra-ocular surgery and a robustness which will stand up to the shock of sudden adversity are necessary for the make-up of an eye surgeon.

Instruments.—Instruments used in eye surgery must be perfect Any defect in a knife point the keenness of an edge a spot on a knife blade and faulty contact in fine forceps teeth may prove disastrous to an eye. Such delicate instruments require the most careful handling in sterilization during their use and in drying and cleaning Knives scissors and needles are protected from corrosion by painting with A.C.10 Sterilization is effected by dry heat

Preparation of the patient.—If there exists an active infection of the skin of the eyelids face scalp lacrimal sac or focal sepsis of the teeth nose and throat an eye operation is contra indicated except in such emergencies as acute congestive glaucoma or rapidly extending retinal detachment. A culture is taken from the conjunctival sac 48 hours before operation and the presence of any pathogenic organisms other than *B xerosis* contra indicates an intra-ocular operation

General medical treatment is administered if necessary for diabetes renal disease hyperpiesis chronic bronchitis and chronic constipation. A note is made about the mental state of the patient and his habits concerning alcohol.

Before operation the conjunctival sac is irrigated with normal saline and penicillin drops 2 500 units per ml. are instilled at three-hourly intervals by day between the time of taking the culture and operation

Most intra-ocular operations on adults are done under local anæsthesia and to reduce nervousness and apprehension luminal gr 1 is given the night before operation this dose is repeated two hours before operation and one hour before going to the operating theatre

On the morning of operation the eyelashes are cut

Nursing.—The nursing of patients after an intra-ocular operation is of immense importance and particular attention must be paid to the manner in which a patient with both eyes bandaged is approached

if this is too quiet or too noisy and without warning in a clear measured tone of voice he may move his head suddenly open the operation wound and cause an intra-ocular hæmorrhage or prolapse of intra-ocular contents which may jeopardize the result of the operation Great care is also needed in washing bed making and feeding and the patient must be adequately warned before anything is done for him

Sneezing may be avoided by pressure of the tongue against the roof of the mouth and a finger against the philtrum of the upper lip There must be no straining on micturition and defæcation The bowels are confined for four days at least during which time a light diet is given Alcohol is given to those much accustomed to it

The patient s hands are secured in clove hitch bandages tied to the side of the bed so that he is unable to reach the eyes In the half waking state bandages and dressings have been torn off and the operated eye irreparably damaged As a further protection a shield is fixed with strips of adhesive tape over the operated eye

After a retinal detachment operation the patient s head is placed in a certain position from which it must not be moved for at least 14 days Some elderly patients with both eyes covered after a cataract operation may show signs of mental instability In such an event it is necessary to uncover the unoperated eye

Anæsthesia.—Most intra-ocular operations on adults are done under local anæsthesia to avoid the risks of vomiting and a turbulent recovery after a general anæsthetic

Surface anæsthesia is effected by the instillation of either pantocain 1 per cent or xylocaine 2 per cent followed by adrenaline chloride 1 1 000 for three or four applications at five-minute intervals before operation Some patients have an idiosyncrasy to cocaine which may cause collapse coffee-ground vomiting and even death

Regional anæsthesia is done by the infiltration of Tenon s capsule and the extra-ocular muscles adjacent to the site of operation with xylocaine 4 per cent A block may also be made within the muscle cone and round the ciliary ganglion This ensures anæsthesia of the uveal tract and reduces the intra-ocular pressure a feature of some importance and help in glaucoma and cataract operations

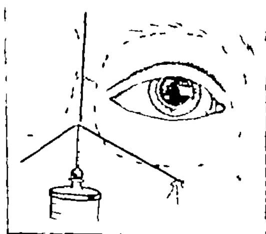


Fig 643 —Orbicularis akinesia Van Lint s method

Orbicularis oculi akinesia is effected by barraging with xylocaine the branches of the facial nerve as these cross the malar bone (*see* Fig 648)

on their way to the orbicularis oculi or where the upper branches of the facial nerve cross the neck of the mandible. Akinesia of the superior rectus is necessary for operations in the upper half of the globe such as cataract and glaucoma in order to prevent the patient from looking up and to eliminate any pain from the presence of the traction suture in its tendon.

General anæsthesia.—Intra-ocular operations which will last 20 minutes or less may be performed under sodium pentothal anæsthesia combined with local anæsthesia to avoid any sudden reflex such as sneezing and jactitation when the eye is touched Relaxants such as curare and d tubocurarine are helpful adjuvants in intra-ocular surgery

Operations for strabismus in children plastic operations likely to occupy a long time and operations involving bone are performed under general anæsthesia unless there is some contra indication

OPERATIONS ON THE LID

Anatomy—The skin of the lids is much thinner than that of any other part of the face it has little and very loose subcutaneous tissue and the hairs consist only of a fine down Under the subcutaneous tissue is the connective tissue covering the orbicularis muscle a well-developed elliptical muscle attached to the medial and lateral margins of the orbit Beneath the orbicularis lies the tarsal plate this is a dense fibrous plate The posterior surface of the tarsus is lined by the adherent conjunctiva. In the lower lid the tarsal plate is smaller than the upper

The muscles lifting the lid are the levator palpebræ a band from the superior rectus joining the levator and to some extent Müller s muscle and the occipito-frontalis The levator arises from the apex of the orbit close to the origin of the superior rectus and is inserted chiefly into the anterior surface of the tarsal plate to the skin of the upper lid and into the upper fornix of the conjunctiva. The frontalis acts by raising the brows thus draws up the skin of the lid and thus accentuates the action of the levator but has very little effect when acting alone unless some more direct connection can be made between the lid and the brow The band from the superior rectus has even less action in raising the upper lid.

A brief outline only of some of the commoner plastic operations on the eyelids is given below

Ptosis

The condition may be congenital or acquired. The *congenital* form which is usually bilateral is due to want of development of the levator palpebræ the *acquired* form commonly unilateral is due to paresis or to direct injury to the levator palpebræ superioris muscle.

When the condition is permanent unsightly and severe enough to interfere with vision surgical measures are necessary except when diplopia appears on lifting the drooping lid

Surgical treatment depends upon the amount of action detected in the levator palpebræ superioris and the superior rectus If there is some action in the levator it is not paralysed and in such a case it is proper to shorten the muscle by partial resection of its belly and advance it by stitching the shortened muscle on to the anterior surface of the tarsal plate (*see* Fig 644)

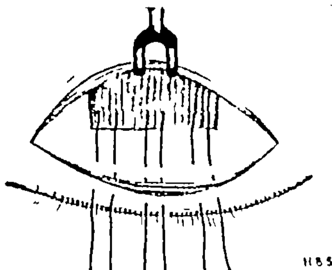


Fig 644 —Ptosis. Advancement after partial resection of levator palpebræ superioris

(Figs. 644 [illegible] are from Stallard's Modern Practice in Ophthalmology Butterworth.)

If there is no action in the levator and good action in the superior rectus a strip of fascia lata is passed beneath the tendon of the superior rectus is carried over the top of the tarsal plate and the two ends are sewn to the anterior surface of the tarsal plate just above the lid margin The fascia lata acts as a loop or sling between the superior rectus and the tarsal plate so that when looking up the upper lid is drawn up by contraction of the superior rectus muscle.

However as a general principle it is undesirable to overstrain the superior rectus muscle In such circumstances some degree of vertical muscle imbalance (hypophoria) may occur and persist at least for a time after operation

In cases where there is no action in either the levator palpebræ superioris or the superior rectus the lid is raised by strips of fascia lata secured to the anterior tarsal plate at the junction of the middle and medial thirds and the middle and lateral thirds and carried upwards beneath the skin of the upper lid and eyebrows to be sewn either to the frontalis muscle or secured in holes drilled through the supra-orbital margin Such a procedure leaves a somewhat fixed and rigid upper lid and the cornea has to be carefully watched for some time after operation for exposure keratitis and ulceration

After any ptosis operation the cornea must be protected by ol. parolein drops applied hourly and by sutures in the lower lid to bring this up over the eye for a week or 10 days after operation

Entropion

Turning in of the lid may be due to spasm of the orbicularis particularly the bundle just below the lower lid margin It is associated with senile atrophy of the tarsus so that this becomes kinked in the middle Other causes of entropion are due to scar tissue beneath the lid more common in the upper lid as a result of trachoma (cicatricial entropion) Spasmodic entropion sometimes follows operations on the globe in elderly patients and may then be due to bandaging The bandage is discarded and the lid held in its normal position with a strip of adhesive tape

1 **Spastic entropion** —The surgical treatment of spastic entropion consists in making an incision starting 5 mm. below and 2 mm. to the nasal side of the midline of the lower lid. This incision is carried

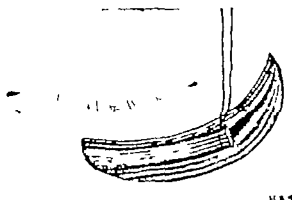


Fig 645 —Spastic entropion lower lid. Wheeler's operation. Dissection of strip of orbicularis muscle.

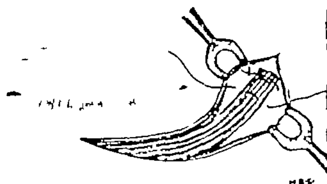


Fig 646 —Spastic entropion lower lid. Wheeler's operation. Suture of strip of orbicularis muscle to periosteum of malar bone

through the skin parallel with the lid margin to the lateral margin of the orbit and thence upwards and temporally to a point over the body of the malar bone about 1 cm above and 2 cm temporal to the

lateral canthus. This latter part of the incision from the lateral orbital margin is deepened through the orbicularis muscle to the periosteum of the malar bone.

A strip of orbicularis muscle 6 mm. wide is now dissected up from the lateral orbital margin to the origin of the incision where it is based (Fig. 645). This strip is now carried upwards and temporalwards over the malar periosteum to which it is sewn by two mattress sutures of 21 day chromic catgut (*see* Fig. 646). The skin incision is closed by interrupted sutures of 00 black silk.

The orbicularis strip acts as a sling and support to the lower lid; it flattens the bent tarsal plate and everts the lid margin.

2. **Cicatricial entropion.**—The commonest cause of this form of entropion is neglected trachoma, which causes scar tissue formation in the subconjunctival tissue of the upper lid. As this contracts the tarsal plate acquires a curve of shorter radius, hence the lashes turn downwards and backwards and may touch the cornea.

There are several methods of dealing with this condition:—

1. The lashes with their roots may be destroyed by electrolysis.
2. The lash-bearing area may be transplanted to a higher level and the raw surface filled in with a strip of mucous membrane.
3. The shape of the lid may be changed so that the lashes no longer point posteriorly.

When a few lashes are badly placed their roots are destroyed by electrolysis. When the whole row of lashes is affected the lash-bearing area is transplanted to a higher level.

Van Millingen's operation.—A strip of mucous membrane is inlaid throughout the length of the lid margin after splitting the lid in the grey line, undermining the lash-bearing area and drawing this upwards. The lid is held firmly in a clamp and an incision is made in the grey line of the lid throughout its whole length and at least 3 mm. in depth. All the hair bulbs should lie in the anterior segment. It is advisable to examine the posterior part of split lid for any misplaced lashes; if found these must be dissected out. The incision must not tail off at either end; it should be of equal depth throughout. A clamp is now placed on the lower lip and two parallel incisions are made in the mucous membrane about the same length as the wound in the lid and 5 mm. apart. The two incisions are joined by a transverse cut at each end and the mucous membrane strip is dissected and any submucosal fat is cut away with scissors.

The strip of mucous membrane is laid over the raw area of the lid margin and is held in position by passing four sutures through each lip of the lid wound and leaving the intermediate part as a loop. When the mucous membrane is in position and the sutures are drawn together these are fixed by strapping. A layer of tulle gras and a roll of gauze wrung out in saline is placed over the graft and secured in position for six days by a pressure dressing and crêpe bandage.

Entropion

Turning in of the lid may be due to spasm of the orbicularis particularly the bundle just below the lower lid margin It is associated with senile atrophy of the tarsus so that this becomes kinked in the middle Other causes of entropion are due to scar tissue beneath the lid more common in the upper lid as a result of trachoma (cicatricial entropion) Spasmodic entropion sometimes follows operations on the globe in elderly patients and may then be due to bandaging The bandage is discarded and the lid held in its normal position with a strip of adhesive tape

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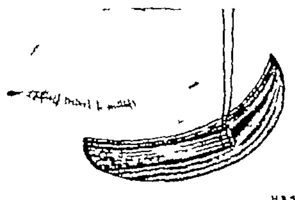


Fig 645.—Spastic entropion lower lid. Wheeler's operation. Dissection of strip of orbicularis muscle.

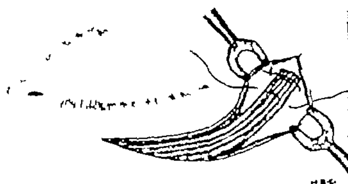


Fig 646 —Spastic entropion lower lid. Wheeler s operation. Suture of strip of orbicularis muscle to periosteum of malar bone.

through the skin parallel with the lid margin to the lateral margin of the orbit and thence upwards and temporally to a point over the body of the malar bone about 1 cm above and 2 cm temporal to the

Eversion of the lid margin. Snellen's operation.—An incision is made 5 mm above the lid margin in the whole length of the lid the orbicularis muscle-fibres are divided and the anterior surface of the tarsal plate exposed. Two parallel incisions about 8 mm apart are made in the tarsal plate throughout its entire length these incisions

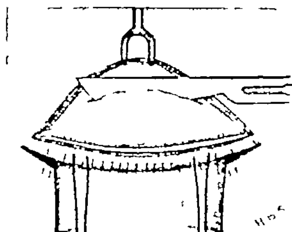


Fig 647 —Cicatricial entropion of upper lid. Snellen's operation. Paring of tarsal plate.

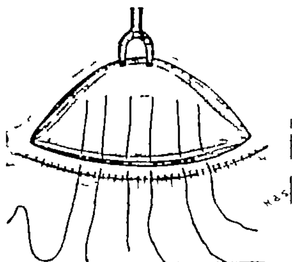


Fig 648 —Cicatricial entropion of upper lid. Snellen's operation. Insertion of three mattress sutures to evert lid margin.

slope towards each other and so a wedge-shaped piece of tarsus is removed (Fig 647) Care must be taken not to perforate the conjunctiva which is adherent to the posterior surface of the tarsus. Three mattress sutures enter the upper part of the incision and pick up the anterior layers of the tarsus then pass deeply through the lower section of the tarsal plate and emerge at the lid margin in the grey line (Fig 648) When these are tied the lid margin is everted (Fig 649)

over the medial and lateral canthal ligaments and an incision 15 mm. long is made in the line of a furrow of the frontal region just below the hair line over the temporal muscle. This last incision is deepened to the temporal fascia One end of the fascia lata strip is first threaded beneath the medial canthal ligament is brought over the anterior surface of the ligament and at the lower border of the ligament it is sutured to the main strip by two mattress sutures of No 1 white silk.

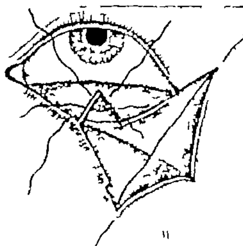


Fig 651 —Atonic (senile) ectropion of lower lid. Kuhnt and Szymanowski's operation. Partial tarsectomy Excision of hair bearing area of lid margin at lateral canthus.

A special introducer (*see* Fig 652) is passed into the incision at the lateral canthus and is directed medially just beneath the lid margin to emerge through the incision at the medial canthus Here the free end of the fascia lata strip is hooked on to the style inside the shaft of the introducer and the fascial strip is withdrawn subcutaneously below the lid margin to the lateral canthus At the lateral canthus the strip is threaded with Galli s needle and is woven through the

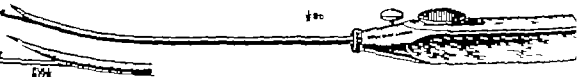


Fig 652 — Fascia lata introducer.

orbicularis muscle at the lateral canthus The introducer is now passed from the temporal incision downwards and medially over the temporal fascia to emerge at the lateral canthus Galli s needle is removed and the free end of the fascial strip is engaged and with drawn subcutaneously up to the temporal fascia where it is again fixed in Galli s needle and is woven through the temporal fascia and then passed back on itself to be secured by two mattress sutures of 21 day

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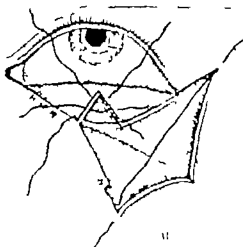


Fig. 651 —Atonic (senile) ectropion of lower lid. Kuhnt and Szymanowski's operation. Partial tarsectomy Excision of hair-bearing area of lid margin at lateral canthus.

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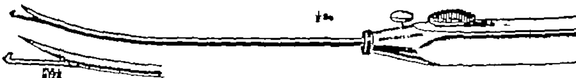


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chromic catgut The incisions at the canthi are closed by two interrupted sutures of 00 black silk and the incision in the scalp over the temporal fossa is *closed in two layers* the deep with catgut and the skin with 0 black silk A lateral tarsorrhaphy at the lateral canthus is also done A three snip operation in the lower punctum and canaliculus and a modified *Z transposition of skin flaps at the medial canthus* will assist in restoring the correct position for the lower punctum

8 **Cicatricial ectropion.**—*The principle of surgical treatment* of cicatricial ectropion is complete excision of all scar tissue and restoration of the lid margin to its proper site A pattern is taken in transparent oiled silk of the raw area left after excising the scar *tissue* It is important to mark clearly with gentian violet the outer surface of this pattern in order to avoid the mistake of cutting a mirror graft

The ideal skin for covering a defect is some from redundant folds in the skin of the upper lid on the opposite side If there is an inadequate



Fig 653 —Ectropion of lower lid. Excision of hypertrophied palpebral conjunctiva. Tarsorrhaphy Bridge-pedicle skin flap from upper to lower lid.

amount available at this site then retro auricular skin carefully chosen to avoid too highly coloured an area tones in well with the adjacent lid skin *A full thickness (Wolfe) graft is preferable to split skin* (epidermal Thiersch) which remains white shrinks by about one-third its size and sometimes becomes corrugated

In the case of severe burns all four eyelids and the retro auricular skin may be damaged and so the only skin available for lid cover is split-skin from the hairless area on the medial aspect of the upper arm It is essential to graft the burnt eyelids before contracture starts generally about the eighteenth day after the injury Third degree burns of 10 mm or more in diameter should be grafted as soon as the œdema of the lids has subsided and the surface is reasonably clean Exposure ulceration of the cornea and subsequent panophthalmitis are the most serious complications of burns of the eyelids

In lid burns the skin of the lid margin generally remains uninjured owing to sudden reflex closure of the eyelids Tarsorrhaphy (suturing together of the lid margins) is necessary in severe cases to ensure

protection of the cornea whilst the grafts are taking and in order to obviate to some extent their subsequent contraction

4 **Ectropion associated with chronic hypertrophic conjunctivitis.**— In such cases it is necessary to excise the exposed desiccated and inflamed palpebral conjunctiva down to the tarsal plate by an elliptical incision which extends from the lid margin to the junction of dry with moist and apparently healthy conjunctiva.

There is some contracture of the skin of the lower lid and this is now incised throughout the full length of the lid 4 mm below the lid

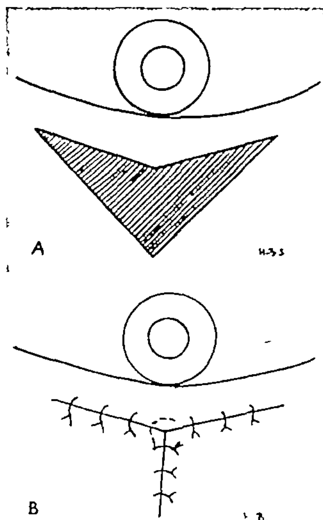


Fig. 654.—Ectropion of lower lid. Wharton-Jones's V Y operation.

margin and the edges of the incisions are undermined sufficiently to allow the lid margin to fall into its proper place against the bulbar conjunctiva. The cut edge of the palpebral conjunctiva is now sutured to the lid margin with interrupted vertical mattress sutures at 4 mm intervals The knots of these sutures when tied are on the anterior surface of the lid margin.

A bridged pedicle flap from the upper lid about 10 mm wide and based at the medial and lateral canthi is brought down and sutured into the raw surface of the lower lid The bridge pedicle acts as a sling as well as affording extra skin (see Fig 653)

Tarsorrhaphy is done in severe cases The donor site of the bridge pedicle graft in the upper lid is closed by undermining the adjacent skin or if this is insufficient by a full thickness retro-auricular graft

In some slight cases of ectropion when there is no cicatrization or loss of skin ectropion of the lower lid may be relieved by **Wharton Jones's V-Y operation.** Two incisions are made from just below the inner and outer canthi converging to meet 25 mm below the lid The skin of the lower lid is freed from the subcutaneous tissue until the lid can be replaced in position This will leave a raw surface below the lid and if sutures are passed to bring the edges of the wound together the V (Fig 654 A) is changed into a Y and the lid supported in its proper position (Fig 654 B)

Tarsorrhaphy and Canthorrhaphy

The purpose of tarsorrhaphy is (1) to protect the cornea from exposure keratitis in progressive exophthalmos neurotrophic disorders associated with disease of the Gasserian ganglion cicatricial

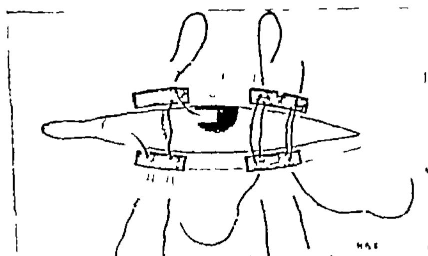


Fig. 655 —Tarsorrhaphy

contraction of the eyelids and certain cases of corneal ulceration and keratitis of long standing which show little sign of healing (2) As a temporary expedient to place the eyelids at rest during plastic reconstruction of the eyelids and conjunctival socket for an artificial eye

The main steps of the operation are shown in Figs 655 and 656 The sites of the incisions in the grey line of the lid margin are carefully marked with gentian violet dots so that these lie opposite each other in the upper and lower lids In some instances a single median

tarsorrhaphy in the midline is all that is necessary in other cases two paramedian sites are essential

The insertion of Kilner s plastic hooks gives adequate traction on the lid margin and by lifting the lid with the hooks effective hæmostasis is produced Hæmostasis is also assisted by the injection of xylocaine and adrenaline at appropriate sites in the lid margin The grey line is split for a depth of 2 mm. by a Gillette knife and care is taken not to incline the blade of the knife anterior to the grey line for if this happened the lash roots would be seriously injured and trichiasis would follow An incision parallel and posterior to the first is made just anterior to the sharp posterior margin A ground down cataract knife is now passed beneath the epidermis of the lid margin between the two parallel incisions and is swept along on the flat between these incisions The edge of the knife is turned towards the surface at the end of the incision and the quadrilateral piece of lid margin is excised. A similar procedure is done at the other sites. It is better to operate on the lower lid first to avoid the field of operation being obscured by blood gravitating from above The centre of each raw area is incised vertically to a depth of 2 mm to allow spreading of the raw surface.

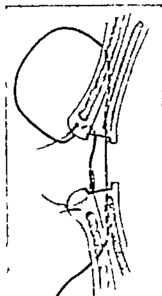


Fig 656 —Tarsorrhaphy Vertical section through eyelids to show apposition of raw surfaces by vertical mattress sutures.

The raw surfaces on the lid margins are thoroughly dried and all blood clot removed before the vertical mattress sutures (*see* Figs 655 and 656) which unite them are tied These sutures are removed on the fourteenth day after operation. The patient is able to see through the chinks between the tarsorrhaphy sites and treatment of the eye by irrigation drops and ointment is possible through these apertures

As a congenital defect the palpebral fissure is occasionally very much too large for the eye In such cases a lateral canthorrhaphy will relieve the defect

Reconstruction of the Eyelids

As a general principle of plastic surgery it is better to reconstruct a defect in the skin or full thickness of the eyelid by sliding adjacent flaps whenever the defect is of such a size that it may be filled without traction or distortion of the neighbouring structures In the case of large defects and total loss of an eyelid such a procedure is impossible nor is it feasible in the latter case to use a free skin-graft when the full thickness of the lid is lost In either case a bridge-pedicle flap lined by buccal mucous membrane or a lined pedicle graft from the fronto-temporal region must be done.

Pedicle grafts are functionally and cosmetically less satisfactory than free skin-grafts and should only be used in extensive loss of the full thickness of either lid They remain somewhat thick rigid and pale in colour

In the case of total loss of the lower lid the cornea may be protected and time gained for lining a bridged pedicle graft of the skin of the upper lid or cheek by suturing the upper lid margin to the raw surface at the infra-orbital margin The case is very different in the total loss of the upper lid Here it is necessary to cover the cornea at once This is done by undermining the bulbar conjunctiva and any remaining conjunctiva of the upper fornix and turning this conjunctival flap downwards over the cornea against which its epithelial surface lies its raw subconjunctival surface being forwards The free edge of the conjunctiva is sutured to tarsorrhaphy sites prepared on the lower lid margin The raw subconjunctival surface is then covered by a fronto-temporal flap based on the temporal region The lower edge of the pedicle is sutured to the raw surfaces prepared on the lower lid margin and to the skin edge below the eyebrow

The pedicle is not divided for at least three weeks When necessary and this is seldom so supporting structure may be given by implanting a thin shaving of auricular cartilage as a substitute for the tarsal plate It is important to remember that the perichondrial surface of the cartilage graft must be placed deeply for a concavity occurs on this aspect of the graft

Eyelashes may be implanted from a narrow full thickness graft of the lower part of the eyebrow The direction of the lashes requires thorough post-operative training with grease massage.

Eyebrows may be replaced by a full thickness graft taken from the temporal region Care is taken in dissecting away the subcutaneous fat not to damage the bulbous hair roots and in placing the graft in its bed to see that the direction of the hairs is temporalwards.

(For fuller details of reconstructive work the reader is referred to special books on Eye Surgery)

OPERATIONS ON THE EXTRINSIC MUSCLES OF THE EYE

Anatomical considerations.—The four rectus muscles arise from an oval fibrous ring which is attached to the medial side of the optic foramen and after bridging the sphenoidal fissure is inserted into a prominent spine on the posterior border of the great wing of the sphenoid. The muscles therefore enclose the optic nerve at their origin and diverge from one another as they pass forward to reach the equator of the globe Here their sheaths become continuous with the capsule of Tenon The superior rectus is in relationship with the levator palpebræ which lies on its upper surface for the first part of its course and before it reaches the equator the superior rectus has the superior oblique below it The inferior rectus lies above the inferior oblique After passing the equator the four rectus muscles

follow the curvature of the globe and become tendinous at their insertions in the sclerotic. The tendon of the lateral rectus muscle is the longest being about 2 5 to 8·0 mm the medial rectus is about 1 to 1 5 mm. and the muscle fibres of the superior and inferior rectus and the inferior oblique pass almost directly into the scleral fibres. The muscle fibres have a special quality in that the bundles are more readily separated than those of skeletal muscle and the nerve supply relative to the size of the muscle is considerably greater The insertion of the medial rectus is 5 mm from the edge of the cornea that of the inferior rectus about 6 mm with its centre slightly to the medial side

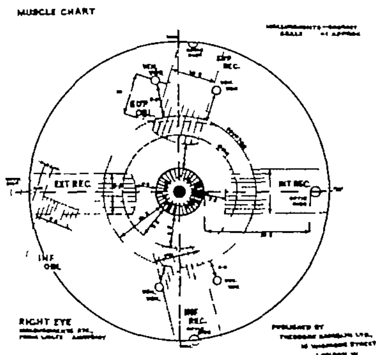


Fig 657 —Chart to show details of insertions of extra-ocular muscles.

of the vertical meridian of the eyeball the insertion of the lateral rectus is about 7 mm. and of the superior rectus about 8 mm. from the cornea, slightly to the lateral side of the vertical meridian.

The connective tissue of the anterior part of the orbit is of great importance. The sheaths of the muscles and the connective tissue between them on reaching the equator of the globe spread out forwards and backwards over its surface to join the capsule of Tenon. This fibrous sheath forms the anterior boundary to the orbital cone of fat. In front of the equator the capsule passes forwards under the conjunctiva and over the tendons of the rectus muscles to blend about 3 mm from the margin of the cornea with the episcleral and subconjunctival tissues and into this blended mass the tendons send prolongations. Just behind the equator a sheet of fascia splits off from the sheaths of the muscles to become attached all round the

bony ring of the orbit The medial and lateral rectus muscles are inserted in the horizontal meridian of the eye and the movements resulting from the contraction of these muscles are simple adduction and abduction The superior and inferior rectus muscles take an oblique course from their origin to their insertion and their action is complex that of the superior rectus is elevation adduction and medial rotation of the upper part of the vertical axis of the globe—intorsion that of the inferior rectus is depression adduction and extorsion The maximum elevation and depression effected by the action of these muscles is when the eye is abducted and so in paralysis of either of these muscles the greatest displacement of the false image from the true will be on attempting to move the eye up or down respectively when it is in the abducted position

The action of the obliques are also complex The superior oblique turns the eye downwards and laterally and in so doing rotates the vertical meridian of the globe—intorsion The inferior oblique moves the eye upwards and laterally and also rotates it (extorsion) The greatest excursion of the oblique muscles is when the eye is in the adducted position. For instance overaction of the inferior oblique is most marked in adduction when the eye on the affected side will turn upwards and medially while the other eye remains abducted in the horizontal position Direct vertical movement of the eye is therefore the result of a combined action of the superior rectus and the inferior oblique and direct downward movement is the resultant of the combined action of the inferior rectus and the superior oblique

In conjugate movements contraction of a muscle is accompanied by relaxation of its ipsilateral antagonist and contraction of its contra lateral synergist For instance contraction of the left medial rectus is associated with relaxation of the left lateral rectus and contraction of the right lateral rectus In convergence on near objects both medial rectus contract and both lateral rectus muscles relax

In paralytic squint there occurs in time contracture of the ipsilateral antagonist and overaction of the contralateral synergist

SQUINT

A squint may be *concomitant* that is the angle of deviation remains the same in any position in which the eyes are moved in a conjugate manner In *paralytic* strabismus when the eyes are turned away from the direction of the action of the paralysed muscle the angle of deviation lessens and disappears and it increases progressively as the eyes are turned in the line of action of the paralysed muscle.

In *latent* strabismus (heterophoria) deviation of an eye appears only on breaking binocular vision.

In concomitant strabismus the correction of the refractive error by glasses will reduce the angle of deviation about 10° Orthoptic exercises which cannot be given until the child is about 4 years or over will in favourable cases when the child co-operates correct about 10

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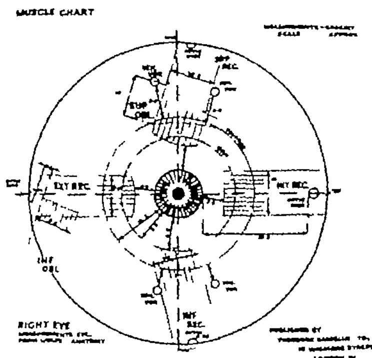


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In concomitant strabismus the correction of the refractive error by glasses will reduce the angle of deviation about 10° Orthoptic exercises which cannot be given until the child is about 4 years or over will in favourable cases when the child co-operates correct about 10

Surgical intervention is indicated when a deviation of over 10° remains despite the wearing of glasses and orthoptic treatment. In the high angles of squint it is proper to operate when the child is 18 months to 2 years old and sometimes earlier in order to place the visual axes in a position where stereoscopic vision may be acquired either naturally or by the help of orthoptic exercises when the child is old enough to do these intelligently

The purpose of treatment by glasses orthoptic exercises and surgery is to obtain as soon as possible a good functional (physiological) result in which the establishment of stereoscopic vision will be firm enough to keep the eyes straight as well as the anatomical result of parallel alignment when looking at infinity

Delay in proper treatment during early childhood may leave many children with functionally useless amblyopic eyes with no stereoscopic vision with no hope of entering certain Services or doing certain types of work for which good stereoscopic vision is essential An operation to correct the squint at a later age is therefore entirely cosmetic and only achieves anatomical alignment and is of no functional value. It is well to complete the work before the child goes to school where teasing may alter his character and add to his misery and self-consciousness.

Orthoptic treatment precedes and follows operation about the fourth or fifth post-operative day in children over 4 years of age.

If a paralytic squint shows no sign of recovery at the end of six months operation may relieve the patient of all or some diplopia and enable him to hold his head in a more convenient position

Recession of the contralateral synergist and if necessary ipsilateral antagonist should be done if possible before contracture takes place in the latter muscle and at the same time the paralysed muscle may have to be partially resected and shortened. When the paralysis has not been present for more than nine months transplantation of the lateral half of the superior rectus and the inferior rectus muscles respectively for 5 mm into the tendon of a paralysed lateral rectus muscle is often quite effective in combination with recession of the medial rectus muscle

Choice of operation.—The operations performed for the relief of squint are —

1 Recession
2. Resection

Free tenotomy should never be performed Its dangers are retraction of the muscle behind the equator and no attachment to the eyeball attachment to the eye in a faulty manner so that some vertical displacement of the eye occurs and in the case of the medial rectus attachment to the caruncle and plica with retraction of these structures on adduction of the eye Free tenotomy of the medial rectus may also cause the discomfort of weak convergence for reading and near work

It is doubtful whether advancement of a muscle beyond its normal insertion is any more effective than partial resection of its belly in front of the equator and suture of the shortened muscle to the tendon stump at the site of its original insertion If the site of an advancement operation is explored later the muscle is frequently found adherent to the site of the original insertion and the muscle fibres in advance of this are thin fibrosed and many are atrophied A disadvantage of an advancement operation is that it often leaves a conspicuous raised pinkish elevation beneath the bulbar conjunctiva.

The angle of deviation is carefully measured by the synoptophore Generally every millimetre of recession of the medial rectus corrects 4° of squint and resection of 1 mm of the lateral rectus corrects 2° of

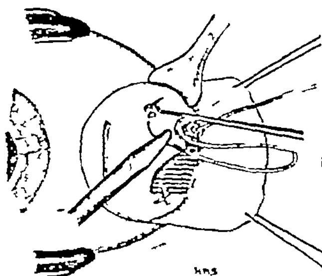


Fig 658 —Recession of right medial rectus muscle

squint The medial rectus should never be recessed more than 5 mm behind its insertion or weak convergence will occur In most cases of alternating concomitant convergent strabismus a 5 mm recession of the medial rectus will correct only 12° instead of about 20° as in the case of a unilateral concomitant convergent strabismus. In the higher degrees of squint it is well to warn the child's parents that more than one operation may be necessary before correct adjustment is made In about 85 per cent of cases a single operation is sufficient Tables have been published setting out the amount of recession and resection necessary to correct certain degrees of squint. These tables are useful guides but cannot be followed slavishly in every case Wilkinson's table is commonly used

Recession —Fig 658 shows the main steps in recession of the medial rectus muscle The conjunctiva is incised 2 mm in front of the

centre of the medial rectus tendon and a curved incision is made with its convexity forwards The conjunctival flap is reflected over the medial canthus and maintained there with two black silk stitches clamped to the head towel.

Button hole openings are made in Tenon s capsule at the upper and lower ends of the muscle insertion the capsule is now incised in a horizontal direction along the upper and lower edges of the muscle. A squint hook is inserted passed beneath the muscle

A few strokes with a muslin swab cleans the muscle and its insertion. Whip-stitches of 0 white silk are passed transversely through the upper and the lower edges of the muscle 2 mm behind its insertion. The

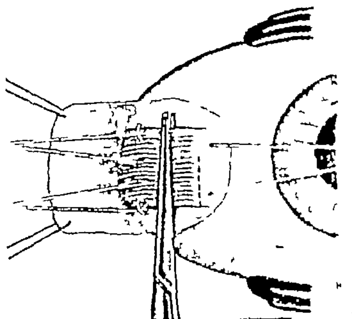


Fig 659 —Resection of right lateral rectus muscle.

sclera is then marked with a dot of gentian violet at points beside the upper and lower margins of the muscle where it has been planned to recess the muscle The tendon of the muscle is then divided at its insertion leaving a 2 mm. frill of muscle in advance of the sutures. The sutures are now passed transversely to the antero-posterior axis of the scleral fibres at the gentian violet marks.

Care must be taken not to insert the point of the needle too deeply As the superficial fibres of the sclera in this region are somewhat transparent the point of the needle should be just visible throughout its course

The sutures are tied and left buried beneath the conjunctival flap The conjunctival incision is closed with a continuous key pattern suture of 00 black silk

Resection.—A vertical incision 10 mm long is made in the conjunctiva about 2 mm posterior to the insertion of the muscle. The

conjunctiva is undermined posteriorly and reflected Button hole snips are made in Tenon s capsule at the upper and lower margins of the insertion and the capsule is incised for 12 mm along the borders of the muscle

The section of muscle destined for resection is marked with gentian violet dots leaving a frill of tendon 2 mm long posterior to the insertion Two mattress sutures of No 1 white silk are passed transversely through the muscle fibres 2 mm posterior to the limit of resection These sutures are then passed in the manner of a whip-

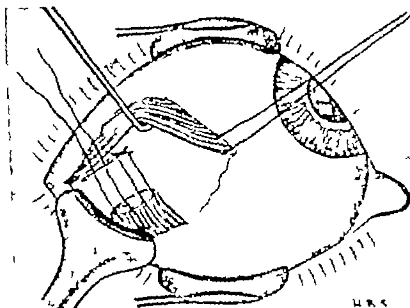


Fig 660 —Recession of the right inferior oblique muscle.

stitch at the upper and lower margins of the muscle (Fig 659) The muscle is then divided 2 mm. anterior to the line of sutures and then 2 mm. posterior to the insertion

The mattress sutures are now passed through the tendon stump the shortened muscle is drawn forward to the original insertion and the sutures are tied with a surgical knot and left buried beneath the conjunctival flap

The conjunctival incision is sewn up with a continuous key pattern stitch of 00 black silk

Recession and resection of the oblique muscles.—Recession and resection operations may be done on the oblique muscles as well as the rectus muscles The superior oblique is exposed through an incision over the superior rectus which is extended about 7 mm on either side of the margins of the muscle The superior rectus is retracted by a No 1 white suture looped beneath its belly and a No 1 black suture through the tendon The insertion of the superior oblique tendon is exposed when the No 1 black suture rotates the eye downwards and the white suture lifts the superior rectus muscle belly

Shortening of the muscle may be done by either resection or pleating and lengthening by recession

The inferior oblique is readily exposed by an incision obliquely downwards and posteriorly from the lower margin of the lateral rectus. The lateral rectus is lifted upwards by a strabismus hook and the eye rotated to the nasal side. A strabismus hook passed into the depths of the wound and swept close to the sclera posteriorly upwards and temporalwards catches the rounded belly of the inferior oblique muscle Either recession or partial resection of up to 10 mm. with two mattress sutures passing through the muscle belly and then the tendon of the muscle may be done for either lengthening or shortening this muscle In the former case the two mattress sutures are tied in the tendinous insertion with the cut edge of the muscle at an appropriately measured distance away (Fig 600) Alternatively the muscle may be sewn to the sclera at a measured distance from the insertion.

Post-operative treatment.—Both eyes are covered by a green binocular mask for two days Post-operative orthoptic treatment is given when indicated on the fourth day and daily thereafter Conjunctival sutures may be removed after 48 hours The continuous key pattern suture is readily pulled out a few minutes after the instillation of pantocain or cocaine

OPERATIONS ON THE LACRIMAL APPARATUS

Surgical anatomy—The lacrimal sac lies in a groove formed by the lacrimal bone and the frontal process of the superior maxilla it is about 12 mm. in length and 5 mm in width the lower end opens directly into the naso-lacrimal duct. The upper part or dome lies behind the medial palpebral ligament and extends for about 8 mm. above it. It is separated from the bony wall of the lacrimal fossa by periosteum and a loose areolar tissue containing a plexus of small veins The angular artery and vein lie on the side of the nose in front of the anterior lacrimal crest

Chronic inflammation of the lining membrane of the lacrimal sac is usually due to obstruction in the naso-lacrimal duct which may be a sequela of chronic rhinitis. The sac is distended with mucus which sooner or later becomes infected causing a muco-purulent dacryocystitis. If the case is of recent origin a cure may be effected by washing out the sac through the lower canaliculus daily and injecting into it an appropriate antibiotic A tampon moistened in adrenaline is placed in the inferior meatus and some adrenaline injected into the inflamed lacrimal sac may effect drainage by shrinking the lining mucosa. If no improvement results an attempt must be made to pass a probe down the naso-lacrimal duct and if this is unsuccessful dacryocystorhinostomy should be attempted

DACRYOCYSTECTOMY

Excision of the lacrimal sac with curettage of the naso lacrimal duct is indicated in the rare cases of tuberculosis disease of the sac and primary malignant neoplasms It is also justifiable in elderly patients in whom the longer operation of dacryocystorhinostomy is contra indicated. It may also be done when the lacrimal sac is severely contracted and extensively destroyed by long stand ing inflammation In young and middle aged patients dacryocystorhinostomy should be tried because excision of the sac leaves permanent epiphora.

A general anæsthetic is advisable but local anæsthesia often suffices The in cision which must be about 30 mm in length begins 2 mm above the upper margin of the medial palpebral ligament and passes downwards and laterally con forming with the curve and the length of the anterior lacrimal crest (*see* Fig 661)



Fig 661 —Incision for exposure of right lacrimal sac.

The superficial fascia and the muscle fibres of the orbicularis are divided down to the anterior lacrimal crest Brigg s retractor is inserted The medial palpebral ligament is now exposed and the sac at once comes into view it may be recognized by its bluish colour The lacrimal fascia is incised along the line of the anterior lacrimal crest and with a blunt dissector the sac is separated from the lacrimal fossa. The dome of the sac is then freed and drawn downwards after its attachments on the ocular side of the wound including the canaliculi have been divided (*see* Fig 662) Finally it is drawn upwards and the lower end divided as close to the nasal duct as possible The depths of the wound must be examined to see that no part of the sac has been left behind and the nasal duct is scraped with a small sharp spoon The retractors are now removed and the wound closed by interrupted sutures of 0 black silk which unite both the cut edges of the orbicularis oculi the orbicularis fascia and the skin at the same time about four sutures are necessary Pressure must be maintained on the wound for at least three days by means of a small inverted truncated pyramid of gauze secured in place by three long strips of ½ in wide adhesive tape.

Dacryocystorhinostomy —Instead of removing the sac an attempt is made to obtain direct communication between the sac and the nose The lacrimal sac is reflected from the lacrimal fossa from which an oval window of bone is removed 1 25 by 1 cm This is done by gently breaking through the thin parchment like bone covering the posterior half of the lacrimal fossa and removing flakes of fractured bone over an area sufficient in size to admit the tip of Citelli s nibbler and then

Ferris Smith's sphenoidal sinus nibbler An angled elevator separates the nasal mucosa from the bone before the nibbling forceps are introduced.

The lacrimal sac and the nasal mucosa are then incised vertically throughout the length of the bony aperture and transverse incisions made across the upper and lower limits of the vertical incision. In

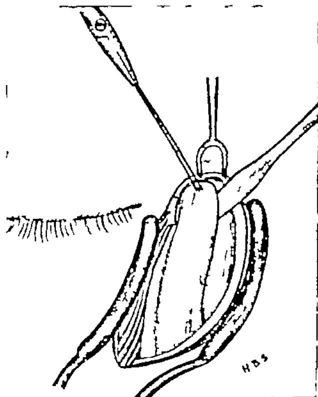


Fig 662 —Right dacryocystectomy Dissection of lacrimal sac.

this way a posterior and anterior panel of nasal mucosa and lacrimal sac are fashioned The two posterior panels are joined by three interrupted sutures of chromic catgut and the anterior panels are united in like manner (*see* Fig 668) Successful drainage of tears into the nose is effected in 89 per cent of cases. In the remainder the ostium closes by cicatrization and it is necessary to try intubation with a polythene tube retained in the lower canaliculus and passing into the nose.

Operation for everted lower punctum—In some cases epiphora is due to a malposition of the lower punctum This should lie with its inner edge in contact with the bulbar conjunctiva if the lower lid is thickened or sags away from the eye the punctum no longer lies in contact and capillary attraction to tears flowing along the sharp posterior margin of the lid does not take place The simple three-snip operation is successful in relieving epiphora if the nasal duct is patent and the eversion of the punctum is slight.

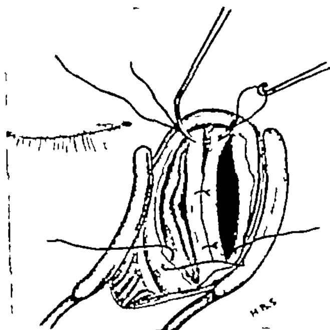


Fig 663 —Right dacryocystorhinostomy Suture of posterior and anterior panels of nasal mucosa and lacrimal sac.

Two or three drops of 4 per cent. cocaine solution and an injection of xylocaine 4 per cent with adrenalin around the lower punctum and canaliculus will make the operation painless The punctum is dilated to allow room for the entrance of scissors and the canaliculus knife The blunt tip of a fine pair of scissors is inserted into the lower punctum and passed vertically down to the ampulla A snip about 1 5 mm long is made With the lower lid drawn outwards the canaliculus knife is entered vertically with the cutting edge towards the nose and then inserted horizontally into the canaliculus for about 5 mm it is now raised with the cutting edge upwards and withdrawn with a cutting movement so as to slit the canaliculus for about 8 mm only It is rarely necessary to make a longer cut than this The conjunctiva is seized and lifted forwards at the site where these two incisions meet at the ampulla. With fine scissors the third snip is made across the base of this triangular flap of conjunctiva, thus joining the beginning of the first incision at the punctum and the end of the second in the lower canaliculus (*see* Fig 664)

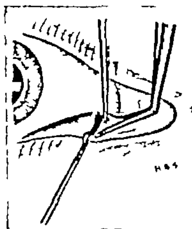


Fig 664 —Three-snip operation.

An alternative to this operation is to touch the conjunctiva and subconjunctival tissues with the tip of an electro-cautery at 1 mm intervals in lines radiating from the lower punctum The contraction of the fibrous tissue at the sites of these electro-cautery

punctures inverts the lower punctum about three weeks after operation

In severe cases of eversion of the lower punctum a plastic operation *is done at the medial canthus to correct ectropion of the lower lid*

Removal of the palpebral part of the lacrimal gland.—There are some cases of troublesome epiphora which persist in spite of freely patent lacrimal passages with the puncta in their proper position In such cases it may be necessary to remove the palpebral part of the lacrimal gland This operation should be approached with caution on account of the danger of inducing keratitis sicca. Local anæsthesia usually suffices The upper lid is everted and the upper edge of the tarsal plate on the lateral side of the fornix is lifted with a fine hook and drawn forwards and upwards An incision is made in the upper fornix for about 10 mm. in length A pair of fixation forceps 3 into 4 teeth is passed into the opening and the palpebral part of the lacrimal gland is drawn down into the wound It is freed from its attachments by means of scissors and as much of it as possible removed. The conjunctival wound is sutured with a continuous key pattern suture of 0 black silk after hæmorrhage has been controlled.

Removal of the orbital part of the lacrimal gland.—The indications for excision of the orbital part of the lacrimal gland are (1) neoplasm (2) tuberculous dacryoadenitis (3) chronic dacryoadenitis with extensive destruction of the gland

A general anæsthetic is advisable The incision about 30 mm. in length is made along the lateral third of the upper orbital margin It divides the skin and orbicularis and exposes the orbital fascia which is attached to the periosteum at the orbital margin This fascia is divided close to the orbital margin when the anterior edge of the gland can be felt just below the bone it is seized with forceps and after its attachments have been freed by means of scissors it is drawn into the wound The lacrimal artery enters its posterior edge and should be ligatured otherwise much orbital hæmorrhage and proptosis will result. After removal of the gland the orbital fascia, orbicularis muscle and skin are sutured in layers and firm pressure applied

OPERATIONS ON THE CONJUNCTIVA AND CORNEA

Pterygium is an overgrowth of chronic inflammatory tissue followed by subconjunctival degeneration commonly on the nasal side which creeps over the corneal margin. If neglected it may invade the pupillary area and interfere with vision If it is progressive it should be removed

The head and neck of the pterygium are seized with forceps and dissected *from the cornea with a sharp knife Whilst still holding* the head diverging incisions are made in the conjunctiva along the upper and lower margins of the pterygium towards the plica semilunaris for 7 mm

The pterygium is thoroughly dissected with the subconjunctival

tissues leaving only conjunctival epithelium to come in direct contact with the sclera The head and neck of the pterygium are excised together with a strip of conjunctiva so as to leave an area of sclera exposed for 4 mm from the cornea-scleral junction This allows the corneal epithelium to grow over the raw area of the cornea before the conjunctival epithelium has grown forwards to the limbus

The conjunctival incisions are closed with two interrupted sutures of 00 black silk

Peritomy—This operation which has been used for over half a century is still valuable when the cornea is covered with superficial vessels from recurrent inflammation If the vessels are limited to one part of the cornea the operation is confined to this area. Local anæsthesia is usually sufficient The incision is made at the limbus with Tooke s corneal splitter and the conjunctiva undermined for 8 mm from the limbus over the affected area The 8 mm. strip of conjunctiva and episcleral tissue thus formed is excised. The superficial vessels running from the sclera into the cornea are sealed off by touching these with a heated probe Beta irradiation and cortisone are given after operation.

Trachoma.—Severe cases may require expression of the granulations by Knapp s roller forceps The lid is everted one blade of the roller forceps is passed into the fornix as far as possible the other blade rests on the conjunctival surface of the tarsus near the lid margin



Fig 665.—Conjunctival hood flap to cover penetrating wound in lower half of cornea.

The forceps is then compressed tightly and drawn down as the rollers revolve the granules are crushed and their contents squeezed out This manœuvre is repeated till all parts of the affected area have been treated Surgeon and assistant must wear protective goggles and gloves for the infective material may spurt some distance

Conjunctival flaps.—These are of great value when dealing with ragged penetrating wounds of the cornea under 5 mm. in length Wounds 5 mm or longer require suturing with 00 black silk on very

fine corneo-scleral needles. If such a wound is very irregular and aqueous is likely to leak through it a conjunctival flap is placed over it. These flaps assist in rapid healing and thus help to prevent infection. The flaps may be cut in various ways —(1) with a broad pedicle (2) as a bridge and (3) as a hood, either partial or complete. The partial hood flap is the most usual. The conjunctiva is incised at the limbus *near the corneal wound and undermined posteriorly for about 8 mm.* In order to bring it well over the wound it may have to be separated for half the circumference of the cornea. When sufficiently free to cover the wound easily it is secured in position by two mattress sutures of No 1 black silk (*see* Fig 665) at the limbus

Penetrating wounds in the centre of the cornea are better covered by a bridge-pedicle flap dissected from the upper part of the bulbar

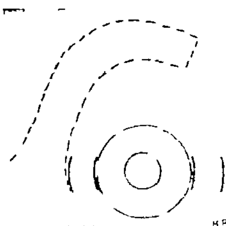


Fig 666 —Pedicle conjunctival flap. The interrupted line shows the flap and the hatched lines the bridges of bulbar conjunctiva under which it passes.

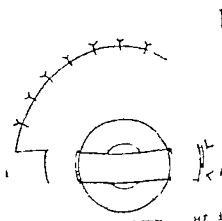


Fig 667 —Pedicle conjunctival flap secured in position.

conjunctiva, based on the temporal side for the blood supply of the flap and secured in position by threading the pedicle flap beneath bridges cut in the conjunctiva at the limbus in the transverse meridian (*see* Figs 666 and 667)

The conjunctiva bridging the cornea is excised at a later date.

Complete covering of the cornea is effected by undermining the bulbar conjunctiva all round the limbus for 8 mm. posteriorly and inserting a purse-string suture of No 1 black silk 2 mm. posterior to the cut edge of the conjunctiva. The purse-string suture when tightened draws the conjunctiva over the entire cornea. This suture cuts itself out about the eighth day after operation and the conjunctiva recedes to the limbus In the meantime the corneal wound has closed.

Neoplasms of the conjunctiva.—Malignant neoplasms such as squamous-celled carcinoma and malignant melanoma commonly occur at the limbus. The bulbar conjunctiva is touched with a surgical diathermy needle making circumvallation of the neoplasm

at least 4 mm clear of its margin Inside this area the neoplasm is shaved off the sclera and cornea with Tooke s corneal splitter Any areas on the sclera and cornea suspicious of malignant infiltration are touched by diathermy The raw area is then covered by undermining the adjacent bulbar conjunctiva and sliding a flap over it

Burns of the conjunctiva —A severe burn of the conjunctiva (e g from a splash of molten metal) is excised carefully removing all necrotic tissue down to the sclera The affected area is covered by a conjunctival flap when possible or, when extensive by amniotic membrane

Corneal Tattooing

Tattooing of the cornea is done to dense white disfiguring corneal scars in blind eyes. (These when situated over the pupil area in an eye with sight may cause much visual discomfort by irregular refraction of light In such a corneal graft is indicated.)

The area for tattooing is outlined with a turn of a trephine 4 to 5 mm. in diameter The cornea is stained with a drop of fluorescein and the trephine-cut in the corneal epithelium shows as a green ring The epithelium inside the ring is scraped away with Tooke s corneal splitter A disc of sterile filter paper the exact size of the area of denuded epithelium is soaked in platinum chloride 2 per cent and placed on the cornea for two minutes. It is then removed and drops of freshly prepared hydrazine hydrate 2 per cent are placed on the treated area for 25 seconds These are washed off with sterile distilled water and then normal saline The treated area stains densely black. The process is repeated if any patches are unsatisfactorily tattooed.

Attempts to tattoo the colour of the iris have been made with Bismarck brown cobalt blue and silver nitrate. In severe unsightly cases a painted contact glass affords a good cosmetic result

Corneal Grafting (Keratoplasty)

This is indicated when there is a dense corneal nebula covering the pupillary area and extending over the iris in any eye which has no active disease and is judged to have an anterior chamber a healthy vitreous retina and optic nerve The presence of broad anterior synechiæ may jeopardize the chance of success by causing vascularization of the graft and so should be divided before a graft is done

The donor material must be human it seems that the blood group is of no importance and there must be no evidence of syphilis acute febrile illness or active disease of the anterior part of the eye. Eyes excised for malignant neoplasms of the choroid and retina and for severe injuries afford a source of supply Cadaver material is being used successfully The cornea is excised immediately after death and kept up to 56 hours in citrated blood at ice-box temperature.

The donor material is cut by placing the excised cornea with its anterior surface downwards in a sterile wax mould cupped to the radius of curvature of the cornea. A trephine 5·0 mm. in diameter is

ssed on to the cornea from the endothelial side and cuts a clean c through the full thickness of the cornea. The graft is kept moist der a gauze tent damped with penicillin

The recipient eye is prepared by orbicularis akinesia, a retro-ocular ection of xylocaine and adrenaline into the region of the ciliary nglion, traction sutures in the upper and lower eyelids and in the perior and inferior rectus muscles These sutures are clamped to the ad towel by pressure forceps The site of the graft is outlined with a

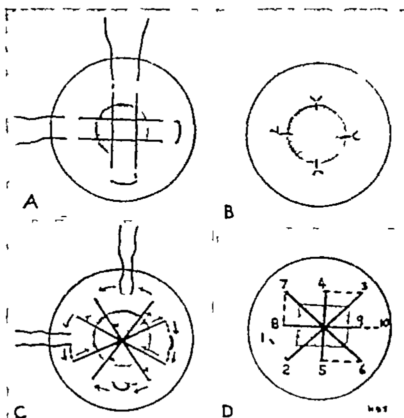


Fig 668.—Corneal graft (transplant) various methods of securing graft by indirect and direct sutures.

mm trephine. If indirect sutures are to be used these are now iced through half the thickness of the cornea in the manner shown in g 668 Alternatively a panel of conjunctiva about 8 mm. wide may fashioned from the upper part of the bulbar conjunctiva of sufficient igth to traverse the cornea and be anchored into a small conjunctival uch fashioned below With such a flap the epithelial surface lies ainst the cornea with its graft and the raw subconjunctival surface es anteriorly

The trephine is replaced vertically on the recipient s cornea. When e cornea has been almost cut through and before entering the terior chamber the trephine is inclined slightly to one side About fifth of the circumference of the disc may remain undivided. The rision is completed by steadying the disc with toothed forceps and

cutting the deeper layers of the cornea either with a blunt-ended corneal knife or Castroviejo s scissors care being taken not to touch the lens The opaque disc is then lifted out and the graft put into place and secured by the indirect or direct corneal sutures (*see* Fig 668B) Atropine and penicillin drops are instilled A green binocular mask is used for 14 days

OPERATIONS ON THE IRIS

Optical iridectomy —The indications are (1) Dense central corneal opacities (2) small dense lamellar cataracts and (3) pupil blocked and fixed by posterior synechiæ

If the pupillary portion of the cornea is more or less opaque and clear cornea is present towards the limbus and for some reason a corneal graft is contra indicated an iridectomy behind the clear portion should improve vision The iridectomy should not extend to the iridic angle owing to the distortion caused by the edge of the lens and in many cases it is better not to divide the sphincter What is required is a button hole in the intermediate zone of the iris This can be done by making a keratome incision about 8 mm long just behind the limbus with curved iris forceps a piece of iris is seized at the required position and drawn into the wound The iridectomy is done with blunt-ended de Wecker scissors placed tangentially on the cornea with the blades radial to the centre of the cornea (Fig 669) The best site for an optical iridectomy is the lower nasal quadrant.

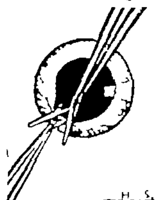


Fig 669 —Optical iridectomy left eye, lower nasal quadrant.

With small dense lamellar cataracts when the vision is much improved with a dilated pupil a small iridectomy to include the sphincter and intermediate zone downwards and slightly medially is indicated.

If the pupil is blocked and adherent to the lens a piece of iris can often be drawn out of the wound by a blunt hook when iris forceps would fail

If the lens is absent an iridotomy may be performed with two Ziegler knives.

Anterior synechiæ —Anterior synechiæ may require division This operation is quite simple if the adhesion consists of a thin stretched band in an anterior chamber of normal depth A narrow linear knife is made to enter the anterior chamber at the limbus opposite the band and swept across it. If a considerable part of the iris is entangled in the wound, a different procedure must be adopted to avoid injury to the lens. Two knives of equal size are required one with a sharp and the other with a rounded end—Lang s twin knives A point is chosen at the limbus opposite the synechia from which the

sharp-pointed knife may pass between the cornea and iris beyond the adhesion This knife is quickly withdrawn without loss of aqueous and the blunt-ended twin is immediately passed through the incision which it fits exactly The blunt tip of this knife is passed beyond the synechia which the blade divides with several short sawing movements.

Fuch's four-point iridotomy—In chronic recurrent iritis complete adhesion of the pupillary margin to the lens may take place. In such cases no fluid can pass through the pupil and in consequence the intermediate zone of the iris is pushed forward leaving a funnel-shaped attachment to the lens The iridic angle becomes blocked and complicated glaucoma supervenes This condition is relieved by the passage

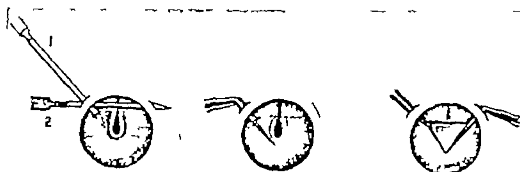


Fig. 670.—Elschnig's capsulo-iridectomy

of a narrow cataract knife from one side to the other in the horizontal meridian The knife should enter at the limbus appear in the funnel shaped depression of the iris and re appear at the limbus on the opposite side when it is withdrawn This will allow the iris to fall back into its normal position and on subsequent examination four small punctures will be seen two on each side of the blocked pupil. The connection between the posterior and anterior chambers is then re-established

Capsulo-iridectomy—The pupil is sometimes occluded after cataract extraction by upward dragging of the iris which is adherent to dense capsular remnants

An opening in the iris may be made beneath the centre of the cornea by inserting a narrow knife about 12 mm long 2 mm wide and with a strong back into the anterior chamber at the limbus in the 6 o clock meridian. The cutting edge is turned towards the iris and when the knife is in its appropriate position in the anterior chamber the handle is quickly elevated and the blade cuts through the iris and capsule in the 12 to 6 o clock meridian.

In cases where the edges of the iris will not retract after such an operation a triangular piece of iris is removed beneath the centre of the cornea by the technique shown in Fig 670

CATARACT

Surgical anatomy.—The lens consists of layers of transparent fibres surrounded by an elastic, structureless capsule. Immediately beneath the anterior surface of the capsule is a layer of cubical cells from which the lens fibres are derived. These cells are of importance for if they remain with the capsule after the lens has been extracted they may undergo metaplasia necessitating an operation for after cataract.

As age advances there is a tendency for the central part of the lens to become more dense, hard and discoloured. The lens capsule is thin at the anterior and posterior poles and the equator and is thicker just in front and behind the equator. This is an important anatomical fact in the intracapsular operation for removal of cataract. The fibres of the suspensory ligament are relatively strong in youth and middle age and friable in the elderly.

Cataract may be divided clinically into hard and soft according to the age of the patient; under the age of 35 the cataract is soft. In soft cataracts, if the lens capsule be opened to allow the entrance of the aqueous to the lens fibres, the fibres swell up and are slowly absorbed. Up to the age of 25 this method suffices but after this age the lens fibres do not easily absorb and extraction is advisable. Between the ages of 35 and 50 extraction is difficult owing to the sticky character of the lens cortex, and much of the cortical matter is likely to be left behind.

The removal of the lens in its capsule has obvious advantages. When successful, it means that no after-cataract can form, and so on that account it is most suitable in a country such as India where patients may have to travel a thousand miles to seek advice.

The operation used to be much more difficult, dangerous and painful than it is to-day, for by newer methods of control of the patient, such as anæsthesia of the orbicularis muscles and deep injection of xylocaine behind the eye, all pain is removed and the danger much reduced.

Senile cataract is usually bilateral. An operation on the more advanced cataract is not advisable until the better eye has lost so much vision that the patient is unable to read, or is obliged to give up his occupation. When cataract is unilateral no operation should be attempted unless maturity or some complication has arisen, such as complicated glaucoma, produced by swelling of the lens.

Previous to 1750 the only recognized operation for cataract was couching, i.e. dislocation of the lens backwards into the vitreous, and even now this method is followed by certain unqualified practitioners in India. The immediate result is excellent, but frequently vision is lost from cyclitis and glaucoma. For these reasons couching is not justifiable unless there is some complication such as lunacy which makes extraction too dangerous.

Surface anæsthesia and vaso-constriction are effected by se... applications of pantocain 1 per cent. and adrenaline chloride 1 ... 1

at five-minute intervals for 20 minutes before operation Akinesia of the orbicularis oculi is effected the lid margins are injected with xylocaine a retro-ocular injection of 1 ml xylocaine 4 per cent with adrenaline is made into the muscle cone and 0·5 ml. into the belly of the superior rectus

Two sutures of No 1 black silk are passed through the upper lid 8 mm above the lid margin and one suture in the lower lid. These traction sutures are clamped to the head towel with pressure forceps.

A No 1 white silk suture is passed through the tendon of the superior rectus and when the eye is rotated into the desired position it is clamped to the head towel. A small flap of conjunctiva is cut and turned down

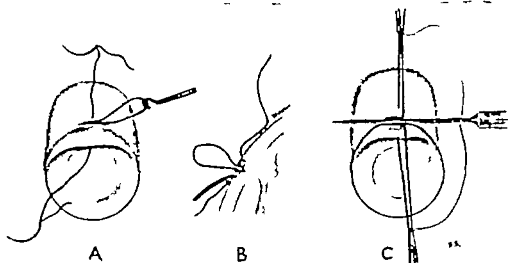


Fig 671 —Cataract extraction. Pre-placed corneo-scleral suture.

over the cornea with its base at the limbus An incision about 2 mm. long is made through half the thickness of the cornea at the limbus A 00 black silk suture is passed across this incision from its posterior to its anterior lip to emerge on the surface of the cornea. The needle is removed from the corneal arm of the suture which is now knotted substantially the knot being drawn flush with the cornea and the suture pulled out of the depths of the incision in a loop so that the cataract knife may pass between the scleral and the corneal arms of the suture without cutting these (Fig 671)

The incision.—The tendon of the medial rectus muscle is seized with fixation forceps which is held forward and never pressed back wards. For the incision a special knife is necessary that originally devised by von Graefe is the best The section is made in the upper half of the eye so that if an iridectomy should be necessary the upper lid will cover most of the iris coloboma The cataract knife is entered on the flat on the temporal side with its cutting edge facing the limbus at 12 o clock. It lies tangential to the surface of the iris (Fig 672)

It must be held forward and never pressed back during the incision When the puncture has been made and the knife is seen to pass across the anterior chamber the operator must remember that the knife is really deeper than it appears and to prevent the counter puncture from being made too far back the point of the knife is aimed at the cornea 1 mm anterior to the limbus The back of the knife must be kept down and no attempt made to cut upwards until the counter incision is complete Then the knife is swept quickly upwards

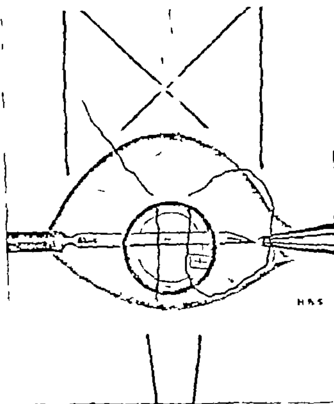


Fig 67x —Right cataract extraction. The corneal section.

first around the nasal side of the limbus and then the temporal side until the blades lie immediately below the limbus between the two arms of the corneo-scleral suture Here its edge is rotated forwards to cut out and complete the section between the corneal and the scleral arms of the suture

Unless the section is made at a certain speed the iris may fall over the edge of the knife If it is evident that the iris cannot be coaxed clear of the knife edge the knife is withdrawn and the incision completed with very sharp blunt-ended corneal scissors

Iridectomy—There is much divergence of opinion whether an iridectomy should be performed or not some holding strongly that a complete iridectomy should always be done whilst others admitting the necessity in certain cases claim that the advantage of a simple extraction more than outweighs the slight danger of prolapsed iris

Prolapse of the capsule remnants is almost impossible when an iridectomy has not been performed A great number of surgeons now believe that the best and safest routine treatment is to do a small peripheral iridectomy at the end of operation It is of course necessary to perform complete iridectomy when the pupil is too small for the forward delivery of the lens through it when there are multiple posterior synechiæ and when the lens is dislocated and extraction by the vectis has to be done.

Capsulectomy—The aim of capsulectomy is to make a central opening in the anterior capsule for visual purposes. This is achieved by the complete removal of the anterior capsule by toothed capsule forceps which is passed closed into the lower part of the anterior chamber then opened for 8 mm and pressed slightly on to the capsule when the blades are closed the capsule is held firmly then with slight lateral movements the forceps is slowly withdrawn. A large hole about 6 mm in diameter is torn in the anterior capsule thereby removing the epithelial cells which if left would form dense after-cataract.

The superior rectus stitch is then released from its clamp before the delivery of the lens.

Delivery of the lens.—A lens expressor is applied to the lower limbus A curette may be used for counter pressure just behind the posterior lip of the wound. The direction of the pressure with the lens expressor is towards the centre of the eye the upper part of the lens is thus tilted forwards and the increased pressure produced in the vitreous forces the lens towards the incision. Slight pressure is necessary on the posterior lip of the wound to engage the edge of the lens in the wound as it passes upwards otherwise there is a danger of the lens being pushed up behind the incision As the lens becomes engaged in the wound the lens expressor follows it upwards and the pressure is maintained but its direction changed to upwards and slightly backwards (Fig 678) When the greatest diameter of the lens is engaged the pressure is changed to a gentle following movement as the lens is delivered. The extraction of the lens from the wound may be assisted by wheeling it upwards and temporalwards with a sharp hook engaged at the equator

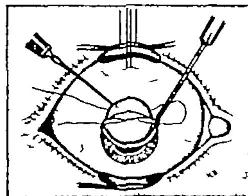


Fig. 673—Right extracapsular cataract extraction. Expression of the lens.

If the sphincter of the iris be too rigid to allow the lens to escape either an iridectomy or a sphincterotomy will be necessary With curved iridectomy forceps the iris is seized a millimetre above the pupil margin and withdrawn a narrow piece is removed with de Wecker s

scissors held with the blades at right angles to the wound resting tangentially on the cornea and pointing upwards

After delivery of the lens the corneo-scleral stitch is drawn taut the needle on the scleral arm of the suture is passed through the conjunctival flap from its deep surface 1 mm above the limbus and the first tie of a surgical knot is made

The tip of an anterior chamber irrigator is inserted into the incision on one side of the corneo-scleral suture and a stream of sterile normal saline at 100° F is directed over the iris and into the pupil At the same time the lens expressor is gently applied to the cornea over the iris root and a few stroking movements are made towards the pupil in order to express remnants of lens cortex pent up beneath the iris The soft lens matter is washed out of the eye The tip of the irrigator with a gentle stream of saline is used to stroke back the iris and tags of anterior capsule

Two iris repositors are inserted into the lower part of the incision one on the temporal and the other on the nasal side The tip of each repositor is directed to the 12 o clock meridian and from thence is swept downwards to the centre of the pupil thereby stroking the iris into place with a round pupil when no iridectomy has been performed and clearing any strands of capsule from the region of the incision The entanglement of capsule in the wound is particularly dangerous as a cause of inducing iridocyclitis not only in the operated eye but in the other eye—sympathetic ophthalmitis

The conjunctival flap is stroked back into place the corneo-scleral suture is tightened so that the lips of the incision are perfectly co-apted and not tightly together and the second loop of the surgical knot is tied

Peripheral iridectomy—A small peripheral iridectomy is done in any case where there is a risk of iris prolapse. The iris is in its natural position and the corneo-scleral suture is not yet tightened. Barraquer s iris-forceps held between the finger and thumb of the left hand is inserted in a nearly vertical direction into the periphery of the anterior chamber a small piece of iris is seized and withdrawn to the edge of the wound and with de Wecker s scissors held in the right hand, the iris is cut below the forceps and as close to their points as possible If the pupil is no longer central the repositor must be used again to replace the iris The edges of the conjunctival flap are closed with several interrupted sutures of 00 black silk tied with the first tie of a surgical knot

The superior rectus suture and the lower lid suture are removed Atropine and penicillin are instilled into the operated eye The sutures in the upper lid margin carry the paralysed upper lid over the eye and the lid is secured in the closed position by strapping the sutures to the cheek with adhesive tape Tulle gras and a double eye pad are placed over the eyes A Cartella shield is secured by strapping over the operated eye and a green linen binocular mask completes the dressing

Complications and difficulties.—*Failure of the lens to present* may be due to an inadequate opening in the anterior lens capsule to the section being too small or to rigidity of the sphincter of the iris the latter is rare. The cystotome should be used to enlarge the opening in the anterior capsule and a further attempt made to express the lens If it does not present because of resistance from the iris a complete iridectomy should be done

Vitreous may present before the lens—In this event the corneo-scleral stitch is drawn in thus closing the wound temporarily When the vitreous face has settled a vectis is then inserted into the wound and directed posteriorly behind the upper pole of the lens it is then passed down behind the lens far enough for its lower edge to reach beyond the lower edge of the lens then by tilting the handle backwards and at the same time slowly withdrawing the vectis the lens may be extracted in its capsule

The lens may pass up behind the incision so that its lower edge appears in the middle of the pupil. It may be possible to deliver the lens by raising the corneal flap and transfixing the lens simultaneously with two Bowman s needles to lift it forwards and out of the wound. If this fails the vectis must be passed in front of the lens with its concavity looking backwards the handle of the vectis is then tilted forwards and made to move through 90° and as the upper edge of the lens comes into view it is withdrawn with the vectis The great danger is that the lens may slip from the vectis and fall backwards into the vitreous

Prolapse of vitreous may be checked by tying the corneo-scleral suture at once snipping off the prolapse with de Wecker s scissors and directing a stream of cold sterile saline into the wound at the site of the vitreous escape The vitreous fibrillar network may be broken up by a few strokes with an iris repositor and in such cases the vitreous will recede into the anterior chamber

Hyphæma during operation is dealt with by immediate irrigation of the anterior chamber before the blood clots In the intracapsular operation blood should be washed off the capsule before applying the capsule forceps for when it is present the forceps slip and do not grip the capsule Blood left in the pupil may organize into dense opaque bands and on the iris may cause iritis

Intra-ocular hæmorrhage—It sometimes happens that a large choroidal vessel gives way as a result of the sudden reduction of intra ocular pressure The extraction is completed without any sign until the toilet of the wound is being done then the wound will be seen slowly to open and a large bead of vitreous appears and when this is snipped off with scissors more and more vitreous shows itself The corneo-scleral stitch is tied at once and if it is possible to see from which quadrant of the eye the choroidal hæmorrhage is coming the sclera should be immediately incised at the site for 7 mm so that the

blood may escape into Tenon's capsule and not into the vitreous. The eye should be covered with a pad and firmly bandaged. Some useful vision may be restored but as a rule it will be found the next day that the blood has forced out the vitreous and even the retina may be in the wound; in such cases the eye must be excised.

There is less likelihood of post-operative prolapse of the iris and of hyphaema if corneo-scleral sutures are used.

Preliminary Iridectomy.—An iridectomy performed some weeks before cataract extraction is justified in cases of cataract complicated by iridocyclitis which has been quiescent for a year or more. The iridectomy gives useful information about the manner in which the eye will respond to operation besides paving the way for a difficult extraction at a later date. Most surgeons prefer a keratome instead of a Graefe knife for the incision as a smaller opening is made.

With fixation forceps held in the left hand the conjunctiva is gripped close to the limbus at the lower end of the vertical corneal meridian. The point of the keratome is placed 1 mm. behind the upper end of this meridian with the blade nearly at right angles to the globe. As soon as the point is seen to have entered the anterior chamber the handle is drawn back so that the blade is parallel with the plane of the iris and the keratome is pushed on until a section of about 8 mm. is made. So far no aqueous should have been lost but as the blade is withdrawn aqueous may escape rapidly and the lens come forward towards the point of the knife. In order to reduce the risk of injury to the lens the handle must be tilted farther back and the knife withdrawn with the point towards the cornea.

Closed iris forceps held in the left hand is passed as far as the upper pupillary edge and a piece of iris in the sphincter region is seized and withdrawn and excised with a single snip of the iris scissors held with the blades at right angles to the corneal incision. The iris usually replaces itself but if necessary the iris repositor is used.

Intra-capsular Extraction of Cataract

A slightly larger incision (about half the circumference of the limbus) is made than for extra-capsular extraction. A peripheral iridotomy is then done. The special capsule forceps is passed into the anterior chamber and under either the upper edge of the pupil or its lower edge; the blades are opened for 8 mm. and the capsule is grasped while pressing the forceps lightly backwards. The forceps is now slowly rotated temporally and then nasally with increasingly larger excursions in the coronal plane whilst slight pressure is applied by a lens expressor just anterior to the limbus at 4, 6 and 8 o'clock. By pressure and traction the lower part of the lens rises into the pupil when this part of it is gripped and by a tumbling movement the lens is drawn into the wound, its lower edge presenting first. Gentle traction and slight pressure on the cornea following the lens upwards complete the extraction. The iris is replaced and the corneo-scleral suture tied.

It must be realized that there is a greater danger of loss of vitreous if the lens is removed in its capsule In the extracapsular extraction the posterior capsule remains behind to support the hyaloid membrane. With improved methods of local anaesthesia and akinesia there is less chance of loss of vitreous but even so an incidence of about 2 to 4 per cent happens with skilled surgeons doing the intracapsular operation. It is advisable for the surgeon to acquire the necessary dexterity by performing many extracapsular operations before attempting the more difficult intracapsular method

Discission

Soft cataract may be removed in two ways (1) By repeated discission The injured lens fibres swell and become slowly absorbed after each operation and when this process has come to a standstill and opaque lens matter still remains the operation is repeated After three or four operations the pupil should be clear (2) By one discission followed by an evacuation of the soft lens matter a few days later The pupil is widely dilated by atropine.

In children under 10 the discission needle should be inserted at the upper limbus and passed as far as the centre of the pupil the capsule is then divided horizontally for a distance of 4 or 5 mm The needle is withdrawn without loss of aqueous. If much swelling of the lens results in pain and increased intra-ocular pressure after a few days the soft lens matter must be evacuated by linear extraction

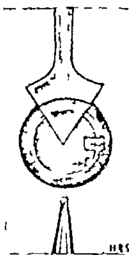


Fig 674.—Linear cataract extraction.

Linear Extraction

In children a general anaesthetic is necessary After insertion of the speculum the conjunctiva is seized just below the limbus in the 6 o clock meridian The point of the keratome is placed just anterior to the limbus at 12 o clock and the blade directed nearly at right angles to the surface. As soon as the point is seen to have entered the anterior chamber the handle is depressed and the blade passed on parallel with the surface of the iris till a section of about 6 mm has been made (Fig 674) The blade must be withdrawn slowly as otherwise the gush of aqueous and lens débris may cause the iris to prolapse The soft lens matter is washed out of the anterior chamber by an irrigation.

After-Cataract

This term is applied to the membrane which forms in the pupil after removal of the lens The term secondary (complicated) cataract is used only for those cases of cataract which follow chronic intra ocular inflammation of the eye

There are various causes for the formation of after-cataract It is certain to form if the anterior capsule is not adequately opened in the pupillary area during extraction It is much less common if the anterior capsule has been removed by capsular forceps Microscopical examinations of avulsed after-cataract usually show a proliferation of anterior capsular epithelial cells forming a thin layer of lens fibres There are some transparent after-cataracts which are due to a puckering of the posterior capsule The more complicated forms are due to inflammatory organized exudate on the surface of the capsule and are often thick and very tough The iris may be firmly united to this with the pupil drawn up towards the corneal incision

The method of treatment depends on the character of the membrane In the simple forms Bowman s method of cutting a small central opening with two discission needles is sufficient to ensure a good result but in the complicated forms a special cutting instrument such as Ziegler s knife is necessary This has a very sharp point a straight cutting edge 7 mm in length and a round shank which exactly fills the opening in the cornea made by the blade in order to retain the aqueous humour

In some cases of capsulotomy two instruments should be used—either two Bowman s discission needles one with the shaft bent at 135° or one needle and one Ziegler s knife or two Ziegler s knives—in order to remove the strain of the suspensory ligament on the ciliary processes The instruments are inserted at the limbus one on the nasal and the other on the temporal sides they enter the membrane at the same spot back to back and then cut away from each other the Ziegler owing to its length of blade will allow gentle sawing movements

Bowman's operation for after-cataract.—With semi transparent membranes a focus lamp is necessary The room is darkened and the lamp placed in front of the recumbent patient about 45° above the horizontal meridian The membrane is examined carefully to note if any dense strands are present An opening is made as near the centre as possible avoiding such strands

After insertion of the speculum one discission needle is placed at the limbus on the nasal side with its blade parallel with the plane of the iris the other at the limbus in the horizontal meridian on the temporal side One needle supports the eye while the other perforates the cornea. The two needles are made to meet at the site of the proposed opening One needle perforates the membrane and as soon as the opening is large enough the other needle enters it. The blade of the right hand needle is now made to cut towards the operator while the other needle cuts away from him In this way an opening of 4 to 5 mm can usually be made behind the centre of the cornea The needles are withdrawn care being exercised that the blades escape as they entered that is parallel with the iris in order to retain the aqueous humour

If many dense strands are present the operation should be performed in a different manner The right hand needle is replaced by a Ziegler's knife. The opening in the capsule should be a little below the centre and the knife with the edge towards the operator by gentle sawing movements is made to cut upwards while the capsule is supported by the Bowman's needle in the left hand.

In the more complicated cases with dense capsule and adherent iris two Ziegler's knives should be used. They enter a common opening at the centre of the pupil back to back, and are then separated by gentle sawing movements until an opening of 4 to 5 mm is made

When dense bands of capsule cross the pupil it is well to pick up and divide a few fibres at a time until the band is severed. Attempts to divide a broad band with a single sweep of the knife-needle often fail and drag on the iris and ciliary body

Ziegler's technique.—Ziegler used one knife-needle only and entered the anterior chamber through the limbus above. He then passed the knife-needle across the anterior chamber and punctured the membrane below and to the left and cut upwards towards the middle line the capsule was punctured below and to the right and incised upwards to the upper end of the previous cut

The proper use of Ziegler's knives eliminates the more dangerous procedures of making a large opening with a keratome and cutting out a piece of the membrane with de Wecker's scissors.

GLAUCOMA

The purpose of surgical treatment in glaucoma is to re-open an occluded filtration angle in the acute congestive type and to establish a permanent fistulous track either between the anterior chamber and the episcleral tissues or between the anterior chamber and the supra choroidal lymph space.

In complicated glaucoma the increased intra-ocular pressure is due to exudation into the aqueous of richly colloidal fluid which drains into Schlemm's canal with difficulty The condition is a complication of iritis and iridocyclitis and is usually temporary When the intra-ocular pressure remains high in spite of treatment an operation is necessary

In chronic glaucoma an operation is indicated if there is progressive loss of visual field any decline in central visual acuity not explainable from other causes and also if the intra-ocular tension does not remain within limits when using miotics

Iridectomy—This is done for acute congestive glaucoma and the periphery of the iris must be torn away to re-open the filtration angle.

A general anæsthetic is desirable Pentothal sodium and curare help to reduce the intra-ocular pressure.

A stitch is inserted in the tendon of the superior rectus and clamped to the head towel when the eye is rotated downwards into the desired

position A small conjunctival flap is cut and turned down over the limbus An *ab externo* incision 6 to 7 mm long is made through the sclera 2 mm behind the limbus and the filtration angle is entered gradually It is well to make the section slowly so that no sudden reduction of the raised intra-ocular pressure may lead to rupture of a dilated intra-ocular blood vessel nor cause a split in the lens capsule From each end of the scleral incision a converging cut is made to the nimbus Closed iris forceps held in the left hand are inserted into the anterior chamber and then opened about 1 mm above the pupil margin to grasp the iris The forceps are withdrawn and a radial section made with de Wecker s scissors on the temporal side (Fig 675) The iris is torn from its attachment along the whole length of the wound and freed with a final radial snip of the scissors on the nasal side. The angles of the wound are freed from any prolapsed iris by a repositor inserted at each end of the wound and swept downwards in the anterior chamber towards the pupil

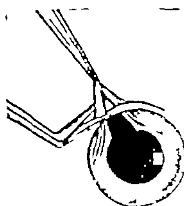


Fig 675 —Glaucoma. Iridectomy Right eye.

It is a good plan when the iris is first seized to attempt an irido-dialysis by pushing the forceps with the contained sphincter towards the lower part of the anterior chamber This gives a better chance of breaking down adhesions at the filtration angle

Some surgeons like to remove a sector of iris 8 mm wide at the filtration angle others state that satisfactory results are obtained with less than this 6 mm Often a wide peripheral iridectomy is sufficient

Despite the fact that iridectomy is an emergency sight saving operation in acute glaucoma the late results are poor The lens becomes opaque and the iris atrophic in a number of cases The results are better with anterior flap sclerotomy and a wide basal iridectomy

Posterior sclerotomy —This operation is of value in certain cases where it is necessary to reduce the intra-ocular pressure temporarily as a preliminary to another glaucoma operation For this operation local anæsthesia is usually sufficient. The site for incising the sclera is the ora serrata, a region between the inferior and lateral rectus muscles. The eye is rotated in the upward and medial direction and a conjunctival flap with its convexity anteriorly is cut 8 mm anterior to the site of the puncture to which surface diathermy is applied A cataract knife with the blade in an antero-posterior direction and the edge posteriorly is passed about 5 mm into the eye and to avoid the lens it is aimed at the centre of the vitreous The section is 8 mm The blade is rotated through a half-circle so as to allow a

bead of vitreous to escape through the wound and is then withdrawn The conjunctival flap is replaced and the conjunctival incision is closed by a continuous key *pattern suture of 00 black silk. The result* of the operation is a slow fall of pressure which may last for 24 hours or more

Lagrange's operation.—A scleral section is made with a cataract knife passed into the anterior chamber between the 11 o clock and 1 o clock meridians A tongue of sclera about 8 mm long is made by inclining the knife edge backwards into deeper layers of the sclera near the completion of the section. A large conjunctival flap is cut turned forwards and dissected free from the tongue of sclera that forms part of the

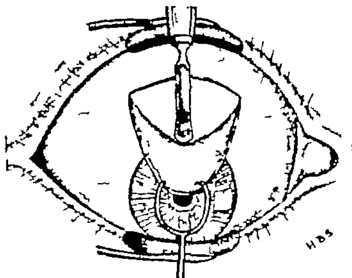


Fig. 676 —Glaucoma. Trephine. Tooke's splitter is separating superficial layers of the cornea.

anterior lip of the wound. The tip of the scleral tongue is seized with forceps and a piece about 3 by 3 mm is cut off with scissors A wide peripheral iridectomy is performed.

Lagrange claimed that this operation was suitable for *all forms* of glaucoma. Many Continental surgeons prefer it to the trephine and claim that the opening *in the sclera has a thicker covering and is better* protected from possible infection.

Elliot's trephine operation.—The purpose of this operation is to establish a filtering cicatrix between the filtration angle and the subconjunctival tissues. Aqueous seeps through the cicatrix and raises the conjunctiva as a bleb The operation decompresses the eye permanently and effectively in 76 per cent. of cases.

A suture is inserted into the tendon of the superior rectus muscle and clamped to the head towel. About 5 minims of xylocaine and privine are injected beneath the bulbar conjunctiva from 10 to 2 o clock between the limbus and the insertion of the superior rectus.

An incision is then made in the conjunctiva 8 mm above and concentric with the limbus from 10 to 2 o clock and the conjunctiva is undermined down to the limbus This conjunctival flap must be handled gently held away from the globe and freed from the subjacent tissues with sharp-pointed straight scissors up to the limbus Here it is necessary to split the cornea for a depth of at least 1 mm This is done with a round-ended knife such as that of Tooke which resembles a chisel with rounded corners (*see* Fig 676) In making this split the line of separation should lie below Bowman s membrane in order to make the anterior part of the flap as thick as possible. If the cornea is divided sufficiently a small crescent of corneal tissue is seen this

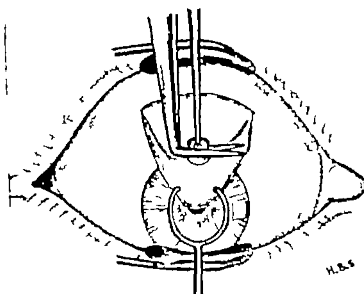


Fig 677 —Glaucoma. Trephine. Peripheral iridectomy

looks dark in comparison with the sclerotic. A trephine (1 5 or 2 mm) is now placed vertically over the filtration angle and it must be remembered that in the upper part of the eye the opaque scleral fibres extend into the cornea for 1 mm The trephine is therefore placed so that its anterior half overlies these scleral fibres To prevent the conjunctiva being cut by its edge this membrane should be held at right angles to the globe and parallel with the trephine. When the trephine is in position it is rotated completely through a full circle for several turns. When it is nearly through the corneo-scleral junction it is inclined forwards so that its anterior edge first enters the anterior chamber and a hinge is left in the deeper layer of the sclera over about one-third of the circumference posteriorly While cutting the disc the surgeon should keep his eye fixed on the upper part of the iris for as soon as the anterior chamber is entered aqueous humour will escape the iris will come into contact with the edge of the trephine and the pupil will be pear-shaped. The trephine is withdrawn directly the iris shows the slightest movement A knuckle of iris should then

be found to be protruding through the trephine hole and the disc pushed forwards and held by its hinged posterior edge. The assistant draws the conjunctival flap downwards the corneo-scleral disc is held in straight fine toothed forceps and cut off with sharp-pointed scissors. Then the knuckle of iris is seized drawn slightly forwards then to either side of the wound and cut off leaving the sphincter and pupil margin intact (Fig 677) A few downward strokes on the cornea with an iris repositor replaces the iris and the pupil. It is important that the pillars of the iridectomy are well clear of the trephine hole otherwise this will become blocked by iris.

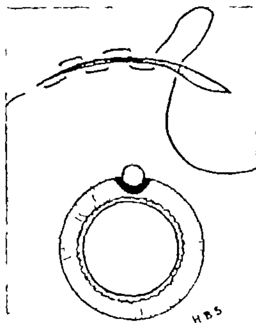


Fig 678.—Glaucoma. Trephine. Conjunctiva sutured by a continuous key-pattern stitch.

The conjunctiva is replaced and the trephine hole examined through the transparent conjunctiva its position should be half in the cornea and half in the sclerotic in other words the limbus should bisect it. As tags of iris may be entangled in the hole this region should be massaged with the back of a curette the iris will thus be squeezed between cornea and lens and can be manipulated away from the opening which is better than pushing the end of an iris repositor into the trephine hole

The edges of the conjunctival wound are united by means of a continuous key pattern fine silk suture which is removed after 48 hours (Fig 678)

The **difficulties and complications** which may occur during the operation are several. It may be found impossible to dissect up a flap of conjunctiva at the site chosen In this case a new site must be found where the conjunctiva is not adherent to the globe. To make certain that the trephine disc is not being cut too far back it is advisable to examine the position of a circular mark made by the trephine at the site chosen for its application, then to replace the conjunctiva in position and note that the circle overlaps the line of the limbus. While the disc is being cut the trephine must be tilted slightly forwards if it is tilted too much the aqueous may escape from a narrow anterior opening in Descemet s membrane through which the iris cannot be made to prolapse. If the trephine is used now there is danger of injury to the lens The patient should be put back to bed and the operation completed at a later date.

If the trephine is held at right angles to the globe without any tilting the disc will be completely freed and may be sucked into the anterior chamber If this happens the disc is generally attached by a fine strand of sclera and may be delivered through the trephine hole by passing a fine sharp hook about 1 mm long on the flat through the trephine hole into the anterior chamber between the iris and the disc The hook is turned forwards and by pressing from behind forwards its point engages the disc which is now delivered through the trephine hole

Later difficulties.—1 The bleb may be too large and overhang the cornea, giving the patient a feeling as of a foreign body This is due to the flap being too superficial on the cornea when splitting the latter

2. Rapid closure of the trephine hole usually due to blocking with uveal tissue results from the trephine hole being too far back The flap must be turned down again and the trephine hole examined If it is found to be too far back another trephine hole should be made under the same flap but farther forward and a little to one side of the first opening When this is completed and not before the prolapsed uveal tissue should be removed from the first opening

3 Delayed reformation of the anterior chamber may cause anxiety Such a complication may cause cataract occlusion of the filtration angle and a recurrence of raised intra-ocular pressure Reformation of the anterior chamber may be achieved by injecting sterile air into the anterior chamber through a scleral incision, made down to the supra-choroidal lymph space as for the cyclodialysis operation (*see* below)

4 Late infection of the trephine bleb rarely occurs It is treated by immediate injections of penicillin 100 000 to 500 000 units in 0·5 ml around the bleb at six hourly intervals for three to five days and by polymyxin in cases of *B pyocyaneus* infections.

5 Choroidal detachment generally undergoes spontaneous replacement when the fluid in the supra-choroidal lymph space is absorbed

Cyclodialysis.—This consists of establishing a communication between the anterior chamber and the supra-choroidal space. It is in effect an internal decompression of the eye the fistulous communication being established between the filtration angle and the supra-choroidal lymph space over a quadrant of the globe It is a useful operation for reducing small rises of intra-ocular pressure and for cases of aphakia complicated by glaucoma.

In the upper temporal quadrant a small conjunctival flap about 8 mm from the limbus is reflected posteriorly to expose the sclera.

The sclera is incised for 3 mm at right angles to the antero-posterior direction of the main scleral fibres and 6 mm posterior to the limbus. When the ciliary body is exposed the anterior lip of the scleral incision is lifted by a sharp scleral hook The cyclodialysis spatula is then inserted into the wound the tip must be pressed against the posterior surface of the sclerotic and pushed forward through the attachment

of the ciliary body to the scleral spur until it enters the anterior chamber in front of the iris (Fig 679) The iris root can now be separated to the required extent by lateral movements of the spatula through a quarter-circle on each side of the scleral incision. The spatula is then withdrawn and the conjunctiva replaced in position and sutured with a continuous key pattern stitch of 00 black silk.

This operation may be repeated if necessary in another quadrant of the globe

In a few cases a severe hyphæma is caused by laceration of an anterior ciliary vessel. Sometimes this is checked by injecting sterile

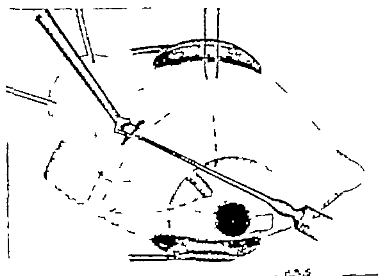


Fig. 679 —Cyclodialysis. Right upper temporal quadrant.

air into the anterior chamber Immediate paracentesis and anterior chamber washout is necessary

Iridencleisis *is a fistula forming operation in which a tag of iris is left impacted in a scleral wound and acts as a filtering wick along which aqueous may seep from the anterior chamber into the episcleral tissues.*

A conjunctival flap is turned down over the cornea as for a trephine operation An oblique incision is made with a keratome through the sclera 2 mm above the corneo-scleral junction and 5 mm. long and concentric with the limbus The keratome enters the anterior chamber After withdrawal of the keratome the posterior lip of the scleral incision is pressed downwards by an iris repositor and the iris prolapses into the lips of the wound. The iris is seized with forceps and divided meridionally from the pupil margin to the root One pillar the temporal is stroked back into the anterior chamber with an iris repositor The nasal pillar is held in the forceps and placed in the centre of the scleral wound with a knuckle about 1 5 to 2 mm in length projecting above the lips of the scleral section The conjunctival

flap is replaced and the conjunctival incision closed with a continuous key pattern suture

Post-operative massage of the globe is often necessary for three weeks after operation

Anterior flap sclerotomy with basal iridencleisis.—I have found the following operation effective for chronic glaucoma A modification of the iridencleisis operation is also of value in the surgical treatment of hydrophthalmia (infantile glaucoma) The operation consists of fashioning a flap of sclera hinged on the limbus a limited cyclodialysis and the incision of a basal tongue of iris leaving the pupil intact

A conjunctival flap is dissected down to the limbus as for a trephine operation The superficial vessels of the sclera are touched with a heated probe along the site of the scleral incision which is 2 mm above and concentric with the limbus and 5 mm long The scleral incision is carried vertically down to the ciliary body The anterior lip of the incision is lifted with a fine scleral hook and a cyclodialysis spatula is passed forwards between the ciliary body and the scleral spur (Fig 680) It is swept to either side of the wound With Westcott s scissors converging cuts are now made from each end of the scleral incision down to the limbus so that the base of the hinge at the limbus is 8 mm The iris is now seized with forceps 2 5 mm above the pupil margin drawn up into the incision and a button hole snip is made just in front of the forceps A blade of the iris scissors is passed into the hole and directed nasally and towards the iris root and a cut is made A similar incision is made in the iris on the temporal side The tongue shaped flap of iris thus formed is brought up into the centre of the scleral incision where it is left folded with its apex projecting about 1 5 to 2 mm above the wound The conjunctival flap is replaced and the incision closed with a con tinuous key pattern suture Atropine is instilled

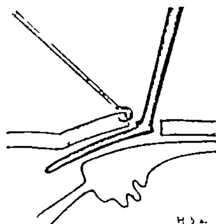


Fig 680 —Anterior flap sclerotomy with basal iridencleisis. Small cyclodialysis.

The anterior chamber is reformed on the day after operation and there is a good thick bleb after one week. To-day this operation has controlled the intra-ocular pressure within 25 Hg mm in 97 7 per cent. of 162 patients 24 of whom had acute congestive glaucoma and the remainder suffered from chronic glaucoma.

Hydrophthalmia (Infantile glaucoma) —The surgical treatment of this disorder is notoriously unsatisfactory In the early stages goniotomy division of the ligamentum pectinatum and stripping the iris root from the posterior corneal surface at the filtration angle for half the circumference of the eye gives fair results

A contact glass is placed on the eye to view the point of the goniotomy knife and to ensure accurate guidance of this in peeling the iris from the cornea in the filtration angle.

In long established and uncompensated cases of hydrophthalmia, anterior flap sclerotomy with iridencleisis gives I think, better results than the trephine and other anti-glaucoma operations. The operation is performed as described above but with a modification in the iridencleisis The iris is cut meridionally from the pupil margin to the root in the 12 o clock meridian. Both nasal and temporal pillars are drawn up and included in the scleral section

Complicated glaucoma.—Surgical intervention becomes essential when a dangerous rise of intra-ocular pressure is not reduced by medical means

Iris bombé requires *iridotomy* The iris is transfixed in two places by a narrow cataract knife passed through the cornea into the shallow anterior chamber through the iris into the posterior chamber and quickly across this to puncture the iris again and if need be to counter puncture the cornea before withdrawal. Aqueous seeps through the holes in the iris and communication between the anterior and posterior chambers is re-established.

In severe cases of peripheral synechiæ where the iris is extensively bound down to the anterior lens capsule iridectomy is necessary

In cases of iridocyclitis when the anterior chamber is deep and the filtration of aqueous rich in colloid particles is obstructed paracentesis is tried and the incision in the cornea is re-opened daily If this procedure fails a hood conjunctival flap is fashioned and the eye trephined with a 2 mm trephine at 12 o clock An iridectomy extending to the pupil is done and the conjunctival flap is drawn over the trephine hole Eventually the trephine hole becomes blocked but in the meantime the intra-ocular inflammation may subside and the intra-ocular pressure fall to a safe level.

RETINAL DETACHMENT

The principle of the surgical treatment of retinal detachment is to induce around an accurately localized tear or tears in the retina an area of aseptic choroido-retinitis and to drain the inter retinal fluid in the space between the layer of rods and cones and the retinal pigment epithelium. This is effected by determining the site of the retinal hole or holes in relation to the surface of the sclera and at and around this site to apply surface diathermy using a current of about 80 to 100 ma. for 6 to 8 seconds depending on the reaction produced in the choroid and retina and checked by the ophthalmoscope at the time of operation

The inter retinal fluid which is maintaining and increasing the detachment is drained by penetrating the sclera with a diathermy needle 1 mm long at the most dependent site obtainable for drainage Drainage is further assisted by suction.

A careful plan of the ocular fundus the exact site and size of the retinal tear or tears and any other fundus lesion of pathological significance is made as the outcome of several fundus examinations of half to three-quarters of an hour duration with the patient s head in different positions This plan together with one of the topography of the sclera at the site overlying the retinal hole is brought into the operating theatre

Much of the success of this operation depends upon thorough and careful pre-operative reconnaissance

Operation—A conjunctival flap with its convexity forwards is reflected posteriorly over the site of the retinal tear Sometimes it is

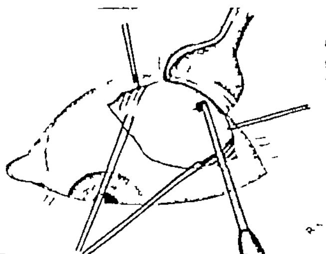


Fig. 681 —Retinal detachment. Diathermy in the upper nasal quadrant.

necessary to divide one of the extra-ocular muscles between two mattress sutures of white silk in order to gain access to the sclera behind the equator In some cases it is possible to retract an extra ocular muscle by a white silk suture looped around its belly

Traction sutures of No 1 black silk are inserted into the tendons of the extra-ocular muscles adjacent to the site for diathermy application (Fig 681)

The sclera is thoroughly dried at the site of the retinal tear and a diathermy terminal 2 5 mm in active diameter is applied firmly to the sclera. The current necessary to induce the desired greyish white coagulation in the choroid and retina around the tear varies in different patients and it is the reaction as seen by the ophthalmoscope after each diathermy application which is the best guide as to the amount of current to use. In most cases this is between 80 and 100 ma. and it is applied for 6 to 8 seconds

The retinal tear is circumvallated with diathermy the intra-scleral punctures being 3 mm apart and in the case of tears at the ora serrata (anterior retinal dialysis) a crescent of diathermy applications is made about 4 mm posterior to the posterior margin and the lateral limits of the tear

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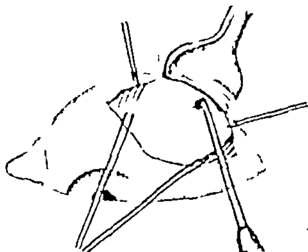


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When the surgeon is satisfied by ophthalmoscopic examination that the retinal tear is completely surrounded by adequate diathermy reaction the sclera is punctured with a penetrating diathermy needle 1 mm long in the most dependent part of the collection of inter retinal fluid except where this is beneath an extra-ocular muscle Several penetrations are made The straw-coloured inter retinal fluid seeps out through the punctures and its removal may be further aided by suction from a glass syringe. In the case of a large balloon like detachment with much inter retinal fluid the removal of a trephined disc of sclera 1 5 mm in diameter with subsequent puncture of the choroid is sometimes indicated instead of penetrating diathermy

Atropine is instilled into the operated eye. Both eyes are bandaged. The patient is nursed for 14 to 21 days in a position where gravity will allow the vitreous to press back the detached retina at the site of the diathermy coagulation and will also allow the inter retinal fluid to drain Thus when the retinal tear is in the lower half of the eye the patient is nursed sitting up in bed when the tear is in the upper part of the eye he lies down with one pillow or no pillow at all and when the retinal hole is in the horizontal meridian he lies on one or other side Careful post-operative nursing and co-operation on the part of the patient are of as much importance to success as a skilfully performed *operation*

The results of the surgical treatment of retinal detachment have improved with better technique. In early cases with favourable features 80 per cent should be successful. The presence of large and multiple retinal tears in a highly myopic eye with degenerative changes elsewhere in the fundus and in the vitreous and a history of long standing detachment are unfavourable features which reduce the chances of success to 25 to 30 per cent The prognosis of retinal detachment in aphakia has been notoriously bad it has however been much improved by lamellar scleral resection an operation which effects shortening of the axial length of the eye by partial or complete circumferential excision of a strip of sclera 3 to 4 mm wide from 10 to 14 mm behind the *ora serrata*.

RADIOTHERAPY FOR MALIGNANT INTRA OCULAR NEOPLASMS

Glioma retinæ (retinoblastoma) is very radiosensitive It is bilateral in nearly 40 per cent of cases By the time the cat s eye reflex is noted by the parents one eye is extensively involved in the neoplasm and excision is generally indicated. If the other eye is affected the neoplasm in this eye is smaller in size than that in the worse affected eye. There may be several small islands of retinoblastoma scattered about the retina If a third or less of the retina is involved in the growth the prognosis after adequate radiotherapy is good The *neoplasm disappears in three to eight weeks* A characteristic scar in the choroid and retina is left at the site of application of the radium

or radon seed The scar is dense white has a pigmented crenated edge the adjacent retina is stippled with fine pigment granules and the retinal vessels are very attenuated

The site and size of the retinoblastoma are carefully mapped out by ophthalmoscopic examination and the sclera at the base of the neoplasm is exposed after reflecting a conjunctival flap and touched with surface diathermy 80 ma. for five seconds to mark the limits of the neoplasm These marks are checked by the ophthalmoscope The area of the neoplasm is carefully measured and the necessary dose of radon or radium is calculated from the area it is required to treat Radon seeds 2 millicuries in strength may be sewn to the sclera over the neoplasm by two strands of 00 black silk threaded with Maddox cataract needles This silk suture is tied in a shallow groove in the platinum envelope midway along the radon seed The seeds are placed 7 mm apart The effective range around each seed is known to be 3 5 mm Discs curved to the radius of curvature of the sclera containing an asbestos ring and disc impregnated with radium salt or composed of irradiated cobalt 60 encased in 0 5 platinum are now preferred for these give a more even dose of irradiation than radon seeds The disc is stitched to the sclera. Four sizes are in use the active diameters of which are 5 7 5 10 and 15 mm

Malignant melanoma of the choroid is less radiosensitive than retinoblastoma Success has followed irradiation with radon seeds and radium disks stitched to the sclera over the site of the growth before it has ruptured Bruch s membrane

EXCISION OF THE EYE

The chief reasons for removal of an eye are —

1 The presence of an intra-ocular malignant growth
2. A perforating wound of the eye of a character likely to produce sympathetic inflammation in the other eye
3 An eye that is blind and painful

As sympathetic inflammation has never been known to occur if the eye is removed within ten days of the injury it is in most cases wise to wait a few days before making the final decision There are however certain injuries which are so severe that delay is useless

Anæsthetic.—The operation requires a general anæsthetic but may be done under local anæsthesia. In either case an injection of 4 ml. of xylocaine and adrenaline is made into the apex of the orbit

Technique of excision—Very careful aseptic precautions must be taken in excising an eye for on dividing the optic nerve and its sheaths there is a direct communication with the meninges and the cerebro-spinal fluid Rubber gloves are worn by all those concerned in the operation. After insertion of the speculum the conjunctiva is seized with plain forceps close to the limbus in the horizontal meridian

around the lower half and then the upper half of the globe and a small incision is made with Tooke s corneal splitter The conjunctiva is divided as close to the limbus as possible it is then undermined and Tenon s capsule opened between each of the four rectus muscles for 8 mm posterior to the limbus This is done with a pair of blunt-ended strabismus scissors With a few strokes of a muslin swab the rectus muscles are cleanly exposed and a suture of No 1 black silk is passed through the belly of each muscle about 8 mm. from its insertion Each of the rectus muscles is now lifted on a squint hook and divided between the suture and the globe. The strabismus hook is now swept posteriorly and temporally from the lateral edge of the inferior rectus muscle and close to the sclera to catch the inferior oblique muscle which is divided about 8 mm. behind its insertion. The strabismus hook is now swept posteriorly and temporally between the upper edge of the medial rectus and the medial edge of the superior rectus to catch the insertion of the superior oblique muscle which is then divided. The screw of the speculum should be loosened and the speculum pressed backwards so as to dislocate the eye forwards. The tendon of the lateral rectus is held in fixation forceps and the eyeball is rotated medially Large scissors closed are passed between Tenon s capsule and the globe on the temporal side to the back of the eye the optic nerve is felt for and having located this carefully the surgeon withdraws the scissors sufficiently to allow them to open he presses the opened blades medially and then posteriorly to cut the optic nerve several millimetres behind the globe. It is possible to excise the full orbital length of the optic nerve by passing the scissors along the medial wall of the orbit and dividing it as it enters the optic foramen. Bleeding may be profuse when this is done. The eye is now lifted forwards and with a few snips through the posterior ciliary vessels and nerves it is completely severed from all attachments. This is sometimes followed by free hæmorrhage which can be controlled by placing in Tenon s capsule a firm ball of gauze to be changed two or three times if necessary and then removed The sutures through the muscle bellies are now lifted forwards and are separated in the direction of the muscles through which they pass. Into the cone-shaped space thus made that is into Tenon s capsule an acrylic mould 10 to 12 mm. in diameter is placed This mould has a concavity on its anterior surface and four loops beneath which are passed the four rectus muscles. The muscles are sewn together in the concavity over this Tenon s capsule is closed with a purse-string suture of No 1 white silk which runs about 8 mm. from its cut edge. When this suture is tied none of the acrylic must show If this is so further sutures across Tenon s capsule are required to bury the acrylic mould entirely

The conjunctival incision is closed with a continuous key pattern suture of 0 black silk. An acrylic form is placed in the conjunctival sac. A firm pressure dressing is placed on the outside of the lids followed by a firm crêpe bandage.

Certain modifications are sometimes required. When the eye has

a large penetrating wound this is first closed by sutures for it is very difficult to do a careful excision of a collapsed eye with intra-ocular contents escaping throughout the operation Great care is needed to keep in the right tissue plane when excising such an eye.

Evisceration of the globe—Evisceration of the intra-ocular contents and the cornea is indicated for gross infection in which there is no hope of any recovery of useful vision Excision of the eye is obviously contra indicated for the sheaths of the optic nerve when opened in the presence of sepsis would endanger the meninges A cataract knife is passed into the anterior chamber in the 9 to 3 o clock meridian at the limbus and it cuts out at 12 o clock in the limbus The corneal lip of the incision is seized in the 12 o clock meridian with toothed forceps and the lower half of the circumference of the cornea is divided with scissors. The entire cornea is then removed An evisceration spoon is then passed into the supra-choroidal lymph space between the ciliary body and the sclera and it is swept backwards in this plane to the optic nerve entrance. The entire intra-ocular contents are now scooped forwards and out of the eye. The scleral cavity is then thoroughly swabbed out with butter muslin swabs care being taken to ensure that all uveal tract is removed particularly around the exits of the vortex veins Remnants of retained and inflamed uveal tract may be a cause of sympathetic ophthalmitis. The scleral cavity is either frosted with penicillin powder or filled with polymyxin B and bacitracin ointment.

In uninfected cases a much better cosmetic result is obtained by the insertion of an acrylic ball into the scleral cup The sclera is stitched over the ball by eight sutures of No 1 black silk

Operations for cases unsuitable for an artificial eye—There are some cases of severely contracted and deformed socket with multiple injuries of the lids in which plastic reconstruction of the socket to hold an artifical eye is impossible or unpracticable under certain circumstances The removal of the lid margins conjunctival sac and tarsal plates is indicated in such cases.

An incision is made about 8 mm. from the lid margin in the skin of both lids beginning at the medial and meeting at the lateral canthi The lateral tarsal ligament is divided with scissors. The lid margins with the whole conjunctiva are now drawn towards the medial canthus and freed from the subjacent tissues by means of the scissors and finally removed by dividing the mass at the medial canthus. The canaliculi are included. The skin margins are sewn together with interrupted sutures of 0 black silk The lacrimal gland which has not been interfered with may have recurrent attacks of swelling for a few months

FOREIGN BODIES IN THE EYE

Diagnosis.—It is an axiom that every eye with a penetrating wound should be considered to contain a foreign body unless the history of the accident and investigations prove otherwise

Good radiographs taken to localize the foreign body are essential.

Diagnostic tests with giant electro-magnets will cause a piece of iron or steel to strike the intra-ocular tunics and inflict pain, but this test is fallacious and a patient should not be abandoned as magnet negative if no pain is felt. It is better when the ocular media are clear to watch the foreign body with an ophthalmoscope whilst the tip of a giant electro-magnet is brought on to the sclera as near to the site of the foreign body as it is possible to place it. Movement of the foreign body towards the magnet indicates its magnetic properties. Certain alloys possess very feeble magnetic properties This is the case with many war missiles.

If the lens is uninjured the fundus clear of blood and the foreign body situated posterior to the ora serrata, it is seen with the ophthalmoscope and its position located Accurate localization is essential for the successful extraction of lowly magnetic intra-ocular foreign bodies.

Position of the foreign body—If the foreign body lies in the anterior chamber it is removed by a keratome incision about 1 to 2 mm longer in Descemet s membrane than the greatest diameter of the foreign body When the foreign body is magnetic it is guided in the aqueous of the anterior chamber by a hand electro-magnet and then brought through the keratome incision and out of the eye. If it is embedded in the lens is less than 1 mm or so in size is surrounded by a localized lens opacity which is not spreading and the eye is quiet it is better to keep the eye under observation If there is severe traumatic cataract with a foreign body in the lens an operation is done to extract the lens and remove the foreign body at the same time. It is not essential to remove an intra-ocular foreign body immediately but it is desirable to do it within a few days of the injury Delay may lead to encapsulation of the foreign body in young fibrous tissue from which it is sometimes difficult to dislodge it.

Non-magnetic foreign bodies such as copper and stone may cause severe inflammatory changes within a few hours of the injury and so must be removed by a special extractor as soon as possible. Non-magnetic foreign bodies situated behind the lens and not causing any irritation may be left alone and kept under observation. In many cases the foreign body is situated in the vitreous and as it is usually of a higher specific gravity than this fluid it will sink to the lower part of the fundus It is in these cases that the character of the substance is of such importance for unless it is of magnetic steel or iron its removal is extremely difficult and the process of doing it may injure the vitreous seriously

Magnet operations.—The best type of giant electro-magnet is one operated from overhead whilst the patient lies on the operating table. It must have a perfect counter balance ball bearing adjustment so that it may be tilted and rotated into any desired position and have fine pointed terminals.

As the pull of the magnet varies inversely as the square of the distance and is directly proportional to the weight of the foreign body great care must be exercised on first testing the eye with the magnet If the foreign body is large and magnetizable much serious damage may be done if the magnet is placed too close to the eye or if full current is used The weakest current should be tried first if the patient feels nothing with the magnet terminal touching the eye the current should be increased gradually

The pupil must be fully dilated Local anæsthesia is usually sufficient but a general anæsthetic may be necessary in nervous patients

There are two routes of extraction of magnetic intra-ocular foreign bodies. The anterior route is more commonly used in civil injuries when smooth oval flakes from a chisel or a hammer less than 3 mm in size may be drawn forward into the anterior chamber without causing any serious injury to the lens ciliary body and iris

For war missiles and other ragged irregular foreign bodies and particularly for those larger than 8 mm in the largest diameter the posterior or scleral route of extraction is undoubtedly preferable and less dangerous than the anterior route. It is possible to extract very feebly magnetic bodies by the posterior route and impossible to do so by the anterior The injured eye settles down well after the posterior route operation but may remain irritable for some time after an anterior route extraction

The anterior route —The patient lies on the table and looks at a small red light on the ceiling of the operating theatre The tip of the giant electro-magnet is brought down to within 1 mm of the centre of the cornea and the current is turned on The iris must be watched carefully for movement which is usually seen in its lower half Immediately any bulge in the iris is seen the current is shut off The magnet terminal is now placed just behind the limbus at a point opposite the appearance of the foreign body in the posterior chamber The current is turned on and the foreign body is drawn clear of the iris and into the pupil The current is then shut off and the foreign body drops down in the anterior chamber and comes to rest on the iris The giant electro-magnet is then removed An incision is made with a keratome 1 mm anterior to the limbus in the upper part of the cornea. The keratome incision through Descemet s membrane is 1 to 2 mm. larger than the largest diameter of the foreign body The keratome is quickly withdrawn without loss of aqueous for the presence of the anterior chamber is essential for the extraction of the foreign body

The tip of a hand electro magnet is placed on the cornea over the site of the foreign body as it lies on the iris and the magnet guides the foreign body to the keratome incision Here the magnet tip is placed on the posterior lip of the wound which opens and the foreign body is attracted to it

Entanglement of the foreign body in the iris necessitates iridotomy after a keratome section in the vicinity of the foreign body and the insertion of the magnet tip into the opening in the iris Occasionally iridectomy with the impacted foreign body is necessary and is an unpleasant and undesirable mutilation

The posterior route.—It is undesirable to extract a foreign body situated behind the lens through the enlarged scleral entry wound unless this lies close enough to the foreign body for its successful attraction to the magnet. When this is not the case the wound of entry may be sealed by the application of surface diathermy around it if less than 8 5 mm. long and by scleral sutures if more than this

A conjunctival flap is reflected with its convexity forwards over the site chosen for extraction of the foreign body The sclera is touched with surface diathermy 70 to 80 ma. for 6 seconds at the proposed site for incision. The length of the incision is 1 mm. more than the longest diameter of the foreign body When the incision has passed through half the thickness of the sclera a suture is passed across the wound a substantial knot is tied at one end and is pulled on to the sclera. That part of the suture which traverses the wound is drawn out in a loop the arms of which are used for traction on the edges of the scleral wound and the deeper layers of the sclera are divided down to the choroid.

The head is now turned so that the scleral wound lies as near the top of the eyeball as it is possible to place it The choroid and retina are then incised with a quick stab from a cataract knife throughout the length of the scleral incision The tip of the giant electro-magnet is swung quickly into place so that the tip just enters the vitreous The current is turned on the foreign body flies to the magnet which is then lifted clear of the wound and the scleral suture is tightened and tied Any tag of choroid entangled in the scleral wound is replaced with an iris repositor Penicillin is instilled into Tenon s capsule and the conjunctival flap is closed by a continuous suture of 00 black silk.

OPERATIONS ON THE ORBIT

A growth behind the eye should be removed as early as possible or pressure may produce atrophy of the optic nerve

If the tumour can be felt an incision about 30 mm in length is *made along the margin of the orbit close to the tumour and down to* the bone the orbital fascia is separated from the bony margin and the space between the bony wall and orbital contents opened up The tumour should be examined with the finger and its depth determined In many cases tumours are encapsuled particularly those in the upper and outer part of the orbit associated with the lacrimal gland and complete removal by excision assisted with a few snips of the scissors is not difficult

If the tumour extends to the back of the orbit and the eye is to be saved a more extensive operation must be undertaken to obtain more room for surgical manœuvre If the eye is blind it should be removed and the tumour dealt with afterwards by a complete or partial exenteration of the orbit

Krönlein's operation—Lateral orbitotomy is the correct approach for removal of a neoplasm cyst or foreign body situated behind the eye and limited to the orbit In the case of a neoplasm good stereoscopic X rays are essential for the investigation of any evidence of extra-orbital extension into the cranial cavity If such intracranial invasion has occurred the trans-frontal approach to the orbit by the neuro-surgeon is indicated Krönlein's operation involves the temporary resection of the lateral orbital wall (Fig 682)

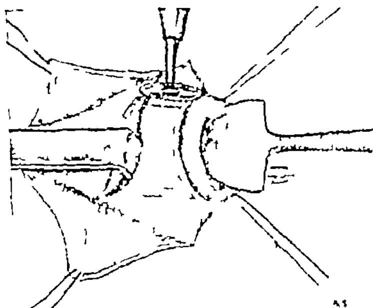


Fig 682—Right lateral orbitotomy (Kronlein's operation) The skin flaps have been reflected. The first cut in the bone at the external angular process is being made.

Operation.—The lid margins are sewn together temporarily to protect the cornea The lines of the incision are marked with gentian violet dots and infiltrated with xylocaine and adrenaline to effect hæmostasis A curved incision 5 mm behind and conforming with the curve and length of the lateral orbital margin is made down to the periosteum of the malar bone. The periosteum along the margin of the orbit is incised and separated by the periosteal elevator from the greater wing of the sphenoid. The orbital contents are held away from the bare bone with a spoon-shaped spatula by an assistant whilst the spheno-maxillary fissure is located. In cases of exploration of the orbit when the presence of a neoplasm is doubtful the periosteum is incised in a line corresponding with the lower edge of the lateral rectus muscle and the operator's gloved little finger is inserted into the orbital contents

The space between the periosteum and the bone is packed with ribbon gauze and the spatula is withdrawn.

From just below the centre of the curved incision a horizontal incision is made posteriorly over the malar bone and along the upper edge of the zygoma down to the periosteum of the malar and the temporal fascia.

The upper and lower triangular skin flaps thus made are undermined, a No 1 black silk suture is inserted into the apex of each flap which is reflected upwards and downwards respectively and retained so by clamping the sutures to the head towel.

The temporal fascia is then incised along the posterior margin of the malar bone and the temporal muscle is stripped from the bone and the temporal fossa and is retracted. The space between the muscle and the bone is packed with ribbon gauze Horizontal incisions are then made in the periosteum at the external angular process and level with the infra orbital margin. The periosteum is reflected with a rougine. Two cuts are then made through the bone at the above sites with Stryker's electric saw The first cut passes posteriorly at the external angular process to the level of the temporal fossa (Fig 682) and the second cut is on a level with the infra-orbital margin and passes posteriorly into the anterior extremity of the inferior orbital fissure. A third bone cut is made with a chisel from the temporal fossa and it joins the posterior extremities of the first and second cuts (Fig 683) The quadrilateral piece of bone is removed with lion forceps and placed in a bowl of sterile normal saline

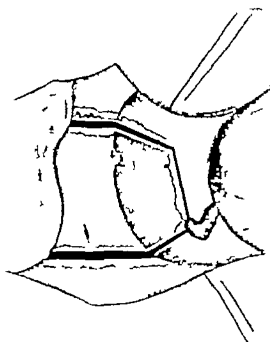


Fig 683.—Right lateral orbitotomy Sites of bone cuts.

The periosteum of the orbit is opened with blunt-ended scissors just below the lower border of the lateral rectus muscle if this has not already been done The lateral rectus is retracted by a No 1 black silk suture looped round its belly Sometimes it is necessary to divide this muscle near the equator of the eye between mattress sutures and reflect the divided ends Division of the muscle farther back than the equator may lead to permanent damage to its nerve supply

The orbital fat is gently separated with a blunt dissector or the

operator's gloved forefinger and the position and size of the neoplasm are discovered Hæmangioma and neurofibroma are easily separated from the adjacent tissues A meningioma of the arachnoid sheath will move to and fro over the optic nerve and may be dissected off the nerve Bleeding is very slight provided the surgeon keeps immediately outside the capsule of the neoplasm Any large vessels entering or leaving the neoplasm are secured in silver clips such as the neurosurgeon uses Mixed-cell tumours of the lacrimal gland may pass posteriorly into the apex of the orbit In the early stages the neoplasm is encapsuled and is easily removed This neoplasm should be handled very little because of the risk of seeding Care is taken not to damage the optic nerve the extra-ocular muscles and their nerve supply and not to injure the posterior ciliary vessels if possible

After removal of the neoplasm any bleeding is stopped the lateral rectus muscle is sutured if it has been divided and the lateral wall of the orbit is replaced with lion forceps It lies neatly in position and does not require wiring or suturing Split rubber drainage tubes are inserted in the lower temporal angle of the orbit and over the temporal fascia horizontally in the long axis of the incision over the temporal muscle The incisions are repaired in two layers the deeper with interrupted sutures of 21 day chromic catgut and the skin with interrupted sutures of 0 black silk The drainage tubes are removed 48 hours after operation the skin sutures on the fourth day and the lid sutures on the sixth day

There is no deformity and scarring is negligible

Exenteration of the Orbit

Exenteration of the orbit is indicated for a malignant intra-orbital neoplasm In some instances it may be possible to leave the skin of the eyelids except for 8 mm around the lid margins and to use these full thickness skin flaps as a partial lining for the orbital cavity Post-operative pain is lessened and convalescence reduced by skin grafting the orbital cavity with a split-skin graft

Operation—Some measure of hæmostasis is effected by injecting the line of the incision and the region of the periosteum lining each wall of the orbital cavity with xylocaine and adrenaline The lid margins are sewn together with two mattress sutures of No 1 white silk In performing complete exenteration of the orbit an incision is made with a surgical diathermy needle down to the bone from the medial canthus along the lower orbital margin to the lateral canthus This incision is continued up the lateral orbital margin along the supraorbital margin and down to its origin at the medial canthus The periosteum all round the orbital margin is incised and with an elevator it is stripped back intact from each of the four walls of the orbit to the apex When the periosteum is completely separated with the enclosed orbital contents the only attachment which remains is at the apex of the orbit and here the tissues are clamped in two angled

mosquito pressure forceps The diathermy needle is passed between the forceps and the orbital contents including the neoplasm are removed A stout ligature of chromic catgut is looped behind the remaining pressure forceps and tied firmly with a surgical knot The forceps are touched with coagulating diathermy and removed. Any areas of bone invaded by the neoplasm are removed with bone-nibbling forceps The cavity is lightly frosted with penicillin powder

A mould is now taken of the orbital cavity A split skin-graft large enough to line the cavity is cut from the medial aspect of the thigh wrapped round the mould with its raw surface outwards and inserted into the cavity Tulle gras fluffed up gauze wrung out in saline wool Elastoplast and a crêpe bandage complete the pressure dressing which is left in place for six to eight days A rubber prosthesis with an acrylic artificial eye eyelids and eyelashes is made to fit the orbital cavity or a painted metal prosthesis may be attached to a spectacle frame and worn over the skin lined orbit.

Orbit —A depressed fracture of the malar eminence may be restored by passing an elevator through a transverse incision 1 5 cm. long in the hair line of the temporal region along the surface of the temporal fascia and beneath the zygomatic arch The surgeon s fingers are placed between the handle of the elevator and the skull so that no damage is done to the scalp or the skull during leverage of the bone fragments forwards and upwards Some assistance in placing the fragments is effected with the thumb and forefinger of the surgeon s other hand.

In severe cases where the fragments will not stay in position an incision is made along the posterior margin of the malar bone and the external angular process and the fragments are wired in position.

The immediate treatment of a depressed fracture of the orbital floor which is associated with fractures of other bones of the middle third of the face is to incise the alveolus transversely over the apex of the antrum of Highmore The surgeon s finger is inserted into the antrum any loose fragments of bone and blood clot are removed and the floor of the orbit is pushed upwards to its normal position The antrum is now packed with ribbon gauze soaked in Whitehead s varnish and this acts as a mould. The pack is removed three weeks later and antrostomy performed.

In cases where the orbital floor has not been restored in this way within 12 days of the injury the eye is elevated by a wedge-shaped bone or cartilage graft inserted beneath the periosteum of the orbital floor A gap is cut to accommodate the infra-orbital artery and nerve

The contour of depressed fractures of the orbital margin is restored by roughening the periosteum in the cavity and filling this with chips of diced cartilage about 4 mm in diameter

CHAPTER XXIX

OPERATIONS ON THE NOSE AND PHARYNX

By W DOUGLAS HARMER and J CECIL HOGG

INTRODUCTION

OPERATIONS on the upper air passages are very common They can be simple or extremely complicated There is always an element of risk even in the simpler procedures and no operation should be undertaken without careful consideration

The **anæsthetic** is most important Modern methods have materially reduced the risks of operations on the air passages but unfortunately there are still deaths recorded during anæsthesia in throat operations In the past most of these were due to the use of chloroform but of recent years obstruction of the airway by the sudden inhalation of blood-clot has been the main cause of fatalities For children general anæsthesia is nearly always necessary but for adults almost any form of anæsthesia either local or general can be employed.

Cocaine is still used for surface anæsthesia more extensively than other drugs in spite of its greater toxicity Patients known to be susceptible should never be given cocaine and in case of doubt a cocaine sensitivity test should be employed. Usually a 10 per cent solution with the addition of adrenaline solution 1 in 1 000 is strong enough for sprays tampons of wool or ribbon-gauze packing but 20 or 25 per cent cocaine in the form of paint or paste is extensively used for deep anæsthesia and for trunk anæsthesia by Sluder s method (Fig 684)

Two useful formulæ are —

℞ Cocain hydrochlor	20 per cent
Sol adrenalin 1 in 1000	20
Gum saline 6 per cent	to 100

or

℞ Cocain hydrochlor	25 per cent
Supra renalin	5
Chloretone	0 75 per cent
Paraffin liq Paraffin molle	aa. to 100 per cent

Sig To be applied to the nasal mucous membranes on a cotton tipped probe.

Sluder s trunk anæsthesia is an effective method of anæsthetizing the whole nasal cavity Two cotton wool probes soaked in cocaine paste or paint are inserted into the nose for 10–20 minutes one of them

lying against the front of the sphenoid to block the nerves entering the nose from the spheno-palatine ganglion and the other high up anteriorly between the lateral wall and the nasal septum in contact with the nasal nerve (Fig 684) Where an operation on the maxillary sinus is contemplated a third probe may be introduced underneath the inferior turbinate bone to supplement the anaesthesia of the antral wall

Adrenaline—For surface application it is usual to add adrenaline solution 1/1 000 in order to bring about shrinking of the membranes For sprays 10 drops to the ounce of anaesthetic solution is sufficient but for wool tampons or ribbon gauze 1 drachm of adrenaline solution to the ounce of 10 per cent. cocaine solution is more effective. In certain patients adrenaline produces severe rhinitis. The constriction

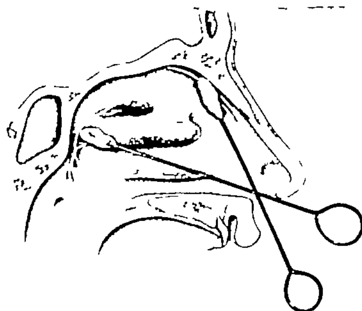


Fig 684.—Anaesthetizing nasal fossa. (Anterior ethmoidal nerve above spheno-palatine nerve below)

of the membranes is followed by swelling and rhinorrhoea and the surface of the mucosa becomes covered by a thick fibrinous exudate which takes days to separate This may block the nasal passages completely and may lead to adhesions between the septum and the turbinates For this reason adrenaline should be used sparingly and strong solutions should not be employed in nasal packs or tampons.

Xylocaine 4 per cent solution with the addition of adrenaline is also a powerful local anaesthetic which is favoured by some operators as it is less toxic than cocaine

Procaine is of little value as a surface application but in strengths of 1 to 2 per cent is widely employed for infiltration anaesthesia. The methods of procuring anaesthesia have improved greatly in recent years making it safer for the patient and easier for the surgeon

Hæmorrhage in operations on the air passages is a serious factor which must never be forgotten When there is any known tendency to bleeding operations should be postponed for determination of the bleeding time and the coagulation time Blood grouping should also be carried out and in doubtful cases all necessary preparations for blood transfusion must be made Except in grave emergency no operation should be performed on an established case of hæmophilia Nasal operations are sometimes attended with severe hæmorrhage but it is almost always possible to control the bleeding and even if a great deal of blood is lost to prevent death from exsanguination and shock Preliminary ligation of the external carotid artery and the replacement of blood by transfusion permits major operations such as removal of tumours of the jaw to be carried out with little or no shock to the patient In one instance temporary ligature of both external carotids made it possible to remove successfully a large pulsating angiofibroma which had been considered inoperable with hardly any loss of blood or shock from the operation The introduction of methods of controlled hypotension has largely superseded carotid ligature but for severe secondary hæmorrhage after operations on the jaw or nasal sinuses blood transfusion and ligation of the external carotid artery are still occasionally necessary

Except for certain conditions which will be indicated later it is preferable not to plug the nose after operation because it causes discomfort and may cause sepsis If however bleeding is still brisk at the conclusion of the operation strips of ribbon gauze which have been soaked in liquid paraffin with powdered bismuth oxychloride or Bipp can be introduced through the anterior nares The nasal fossæ should be packed thoroughly and tightly passing the ribbon to the sphenoidal region along the floor and then packing the upper and anterior parts of the nose This prevents the gauze from slipping down into the pharynx. A narrow piece of adhesive strapping applied from side to side around the front of the nose also prevents the patient from dislodging the pack by sneezing Rarely the posterior nares must be plugged first A roll of gauze impregnated with Bipp (1½ by ¾ in) is firmly tied by a double strand of thick silk A soft rubber catheter is passed through the nose and to the end which appears in the pharynx one of the silks is attached. The catheter is withdrawn from the nose with the silk The soft palate is retracted with a finger and the plug is drawn upwards by the silk so that it is firmly impacted inside the posterior naris To fix it in position the silk can be tied around a second roll of gauze placed just outside the nostril Usually both posterior nares must be plugged and the gauze retained for forty eight hours Such plugging may also be necessary for secondary hæmorrhage occurring several days after operation or for severe forms of epistaxis due to other causes In certain instances the plugging needs replacement after clearing the nose of blood clot

Pharyngeal operations sometimes cause bleeding which may be very

alarming and serious if not properly dealt with (*see* tonsillar bleeding p 1666) In rare instances where an abnormal artery usually the internal carotid has been divided there may be fatal collapse before the vessel can be ligatured When removing adenoids an unfortunate house surgeon actually cut out a complete segment of the internal carotid artery which had projected into the naso-pharynx and the child died although the bleeding was controlled.*

Sepsis.—It is well to remember that the upper air passages are often very heavily infected with virulent organisms and that although the patient may not appear ill his resistance may be poor Considering the great number of operations performed under these conditions serious complications are rare but their possibility should not be forgotten. Excessive trauma may be followed by very severe infection and general toxæmia and a simple operation for polypi or for sinusitis may be fatal owing to meningitis If blood mucus or pus is allowed to pass into the trachea the patient may suffer from serious asphyxia followed by broncho-pulmonary complications. Fortunately most of these complications can now be successfully controlled by chemotherapy or antibiotics

OPERATIONS ON THE NASAL FOSSÆ AND ACCESSORY SINUSES

Submucous Resection of the Nasal Septum

Indications.—This is the operation to choose for the relief of any form of nasal obstruction whether due to displacement of the anterior portion of the septal cartilage to spurs or to a deflection of the septum (Fig 685) for many cases of rhinitis (colds) naso-pharyngeal

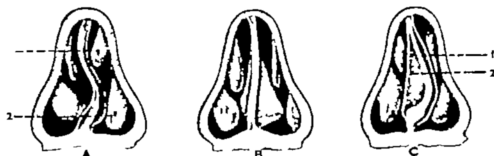


Fig 685.—Varieties of deflected septum.
A, S shaped (1 middle turbinate 2, inferior turbinate) B, posterior spur; C, simple (1 2, reflection of flaps).

Eustachian and laryngeal catarrh for certain lung conditions in patients suffering from air hunger for certain cases of asthma for reflex nasal headaches and to facilitate the treatment of polypi or ethmoiditis or intranasal drainage of the frontal sinus and the antrum.

In children it is rarely performed because of the difficulty of obtaining good results on account of the small size of the nasal fossæ and from fear of causing deformity Whenever possible it is advisable to

* See also *Ann. Roy Coll Surg England*, 1955, xvi, [illegible].

postpone the operation until the nose is fully developed Patients over fifty have generally become accustomed to obstruction and are not likely to be benefited by the treatment The operation should not be undertaken in those suffering from active tuberculosis lupus or syphilis Septic teeth and diseased tonsils should be removed and a reasonable interval allowed to elapse before the operation is performed

Positions of patient and surgeon —Some surgeons particularly when employing local anæsthesia prefer the patient to be in the sitting or semi recumbent position Others make the patient lie in the supine position with the head raised to suit the operator s taste When general anæsthesia is used it is necessary to ensure that the airway is protected by a pack or cuffed endotracheal tube If the patient is

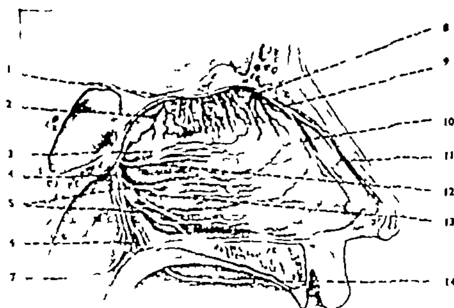


Fig. 686 —Vessels and nerves of lateral wall of nasal fossa.

1 Olfactory nerves ; 2, posterior ethmoidal artery ; 3, lateral posterior nasal branch of spheno-palatine artery 4 spheno palatine ganglion , 5 posterior superior lateral nasal nerves 6, 7 external and posterior palatine nerves to soft palate uvula and tonsils ; 8, anterior ethmoidal artery ; 9, anterior ethmoidal nerve ; 10, internal nasal branch of anterior ethmoidal nerve 11 external nasal nerve (cutaneous) ; 12, posterior superior nasal nerve 13, lateral posterior nasal branch of spheno-palatine artery ; 14 anterior palatine nerve

rolled on to his right side by means of a sandbag under his left shoulder the operator can sit comfortably on the stool facing him a position originally recommended by Butlin to keep blood out of the airway

Either local or general **anæsthesia** may be chosen or preferably a combination of these methods Local anæsthesia means less bleeding and a more rapid operation

If **plugging** with a local anæsthetic is employed the strips of gauze should be tied together outside the nose to prevent them from being sucked into the larynx and the patient must be told not to swallow the solution

Preparation of the skin.—To prevent infection of the wound from the skin the surface of the nose and the interior of both vestibules should be painted thoroughly with rectified spirit or with a 2 per cent. iodine solution Long hairs inside the nose should have been removed A towel or gauze should be brought over the mouth and fixed with clips to cover it completely

Instruments.—Lamp long speculum scalpel periosteal elevators swivel knife cutting forceps chisel and mallet snare needle and dressing forceps

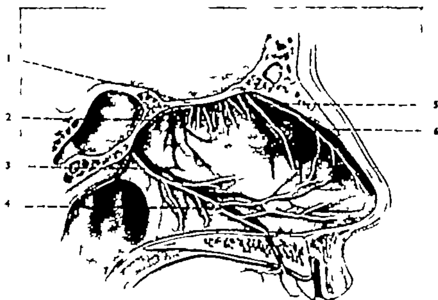


Fig. 687 —Septal vessels and nerves.

1 Olfactory nerves 2, posterior ethmoidal artery ; 3 spheno-palatine artery septal branch ; 4, naso-palatine nerve 5, anterior ethmoidal artery ; 6, medial nasal branch of anterior ethmoidal nerve.

An aspirator for sucking out blood has great advantages as the operation can be performed quickly and with less bruising than when constant sponging is employed.

Technique.—A single linear cut is sufficient and may be made on either side of the septum Some surgeons always incise on the same side either right or left others choose the side of the convexity or where there is likely to be the most difficulty in separating the flap especially when a sharp spur is present. The cut should be well forward on the septum starting above near the bridge under the fold of mucous membrane between the lateral cartilage and the septum The incision passes straight down to the floor of the nose immediately in front of the thickened crest of the maxilla which is nearly always seen just behind the vestibule It is important to divide not only the mucous membrane but also the perichondrium which is often adherent in this position To start the separation of the perichondrium a small sharp elevator is employed the tissue being stripped from the cartilage by careful dissection without hurry It is better to notch the cartilage than to damage the flap at this stage.

Difficulty in separating the flap means that the perichondrium has not been completely divided. But when the separation is once started a large blunt elevator can be used and the dissection carried backwards remembering to keep the edge of the elevator pressed firmly against the cartilage. When the latter is very prominent it may not be possible to elevate a long flap without danger of buttonholing and if difficulty is experienced it is advisable to cut through the cartilage and to commence the dissection on its farther side.

This incision need not correspond with the original cut but must be so placed that it passes anteriorly to the deflection. Great care must be taken not to perforate the mucosa lining the concavity and if

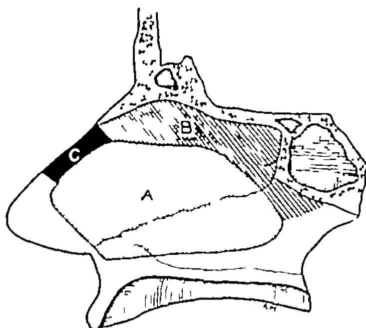


Fig. 688.—Resection of nasal septum.

A, cartilage and bone removed; B, dangerous area; C, bridge of nose (very likely to cause depression of bridge).

necessary the speculum can be introduced for a moment into the opposite nostril. With a blunt elevator it is generally easy to separate the flap far back on this side. The speculum is then introduced in such a manner that the two flaps lie outside its blades and the bare cartilage between them. With a small angular knife or with Ballenger's swivel knife this can be removed in one piece. The portion of cartilage should be preserved in warm saline so that if necessary it can be replaced between the flaps at the end of the operation; this will reduce the risk of the septum flapping subsequently with inspiration. A cavity will then be seen between the flaps and when the blood has been removed by suction or strips of gauze or small sponges of wool the remaining septum must be examined in three situations: (1) High up under the bridge where further dissection is necessary to isolate the deflection. In this region cutting forceps should be employed and care taken not to wrench away the cartilage for fear of causing

a depression of the bridge of the nose (Fig 688 B and C.) (2) The floor where the septum articulates with the crest of the maxilla. This part of the cartilage is tongue-shaped and runs far back along the crest *In separating it the mucosa is easily torn* The wide bony crest can now be seen and it is difficult to determine where its edges are situated because the muco-periosteum is very adherent A sharp elevator is necessary to separate the flaps from it. The cutting must be made directly inwards because the upper part of the crest is much wider than the lower The bone having been isolated completely can be removed with a small chisel or punch forceps. (Fig 688 A) To secure a successful airway it is always necessary to remove this spur completely (3) The septum must be examined farther back as there is generally a prominence which must be removed. Lastly the cavity is thoroughly dried again and explored to make sure that no sharp pieces of bone or cartilage have been left The speculum is withdrawn and the flaps placed in position again The septum should now lie in a straight line from the bridge to the floor and a plug of gauze should pass without resistance through each side of the nose into the naso-pharynx If the operation is performed systematically and without haste it is possible to avoid tears or buttonholing of the flaps It is not essential to suture the flaps which generally fall together in good position but many surgeons prefer to unite the edges of the original incision with one or two sutures inserted with a hook shaped needle

To obtain a good result from this operation attention must be paid to the following points —

1 *The whole of the obstruction must be removed* not only the central portion of the septal cartilage Unless the dissection is carried high up towards the bridge well below the crest at the floor and far back to the posterior nares the flaps will not lie exactly in the middle line.

2. *The flaps must not be torn* Unfortunately this accident is difficult to avoid when the membranes are thin. Provided that the tear is small and is unilateral, or if bilateral does not correspond with the tear on the other side then no perforation will ensue but large tears may result in a perforation of the septum with crusting and obstruction afterwards. A small hole far forwards is to be feared, because a whistling sound may be produced with respiration and can only be cured either by a plastic operation or by enlargement of the perforation. A unilateral tear near the floor of the nose is not so serious as in other parts and may even be beneficial, to prevent a collection of blood between the flaps

3 *Flapping of the septum* After removal of a large part of the cartilage and bone it may be found that the septum is baggy and flaps with respiration. This condition may cause difficulty in breathing and great discomfort. In such cases it is advisable to replace some of the cartilage using one large or several small pieces between the flaps before the incision is sutured If care is taken to prevent sepsis the cartilage rarely necroses

4 After the septum has been straightened *the turbinate bones* ı *always be systematically examined* On the side of the nose which originally concave the inferior turbinate is generally enlarged and septum in its new position often lies in contact with it so that the air is blocked To remove this obstruction the mucosa covering the anti end of the turbinate must be trimmed away freely Even in si enlargements it is important to scar the surface and so cause turbinate to shrink The inferior turbinate on the convex sid flattened and may be so near the outer wall of the nose that the entr to the inferior meatus is a slit through which air cannot possibly ı To correct this deformity a small portion of the anterior end of bone and its covering must be taken away The removal of the post ends may also be necessary in certain cases but it is important n to remove the inferior turbinates more freely than necessary as may result in troublesome dryness and crusting Nasal polyp present can also be removed

The middle turbinates are often unhealthy owing to old stan ethmoiditis In the hollow side of the nose the bone is frequently c and lies against both the septum and the ethmoidal cells Such a dition leads to reflex headaches and prevents ventilation of the u and middle meatus with its consequences The opposite turbina probably a thin shell of bone pressed firmly against the outer wa the nose from which it should be either removed or dislocated s to leave a free passage into the middle meatus The anterior enc the middle turbinates can be amputated without fear whenever are inflamed or are causing any obstruction in the upper part of nose Those surgeons who boast that they never take more than minutes to complete a submucous resection cannot have realized importance of the treatment of the turbinates

5 *Drainage of the sinuses may be necessary* In cases complic by sinusitis drainage may be necessary to cure the catarrh question arises whether it is better to treat the accessory sinuses at same operation or later and it is impossible to lay down very defi rules on this point In general the wounded septum heals well (when there is pus in the sinuses but surgeons will be well advised n attempt too much at one sitting for fear of sepsis

Plugging the nose.—The use of plugs after this operation is gene advisable for prevention both of epistaxis and of hæmatoma betv the flaps The latter is more important as when the nose is plugged blood nearly always collects to some extent between the fl causing the septum to be unduly thickened a condition which prev the patient from breathing through the nose for many days. danger of sepsis is also increased. Many forms of plug have l suggested Hollow tubes offer certain advantages but if rigid enc to allow the patient to breathe through them they are likely to c neuralgia and headache so are badly tolerated Strips of gauze so in liquid paraffin containing oxychloride of bismuth 20 per cent

effective for keeping the flaps accurately in place the oil preventing the gauze from becoming adherent Another method is to insert into the nasal fossæ two rubber glove-fingers which have been lightly filled with wool so that they are large enough to block the cavities completely These plugs should be united by a strip of rubber to prevent their being sucked into the larynx and they should be retained in position by a thin piece of adhesive strapping which grips the sides of the nose. The strapping should not be applied across the bridge of the nose lest it cause a depression The plugs can be easily removed after twenty four hours unless bleeding persists As a rule no further after treatment is required but care should be taken to remove any sloughs and to prevent the formation of adhesions This can be effected either by passing a small swab of wool through the nose daily or by gentle syringing with normal saline solution if the mucus is excessive. Constant applications of liquid paraffin either by spraying or with wool are valuable and prevent inflammation

Results.—Submucous resection of the septum if properly carried out gives such excellent results that all other operations have been discarded The patient can breathe freely through both sides and can ventilate all parts of the nasal fossæ The operation causes no external deformity but on the contrary tends to improve the appearance of the nose by correcting the lateral displacement The mucosa remains intact the wound is small and heals rapidly without crusting Hæmorrhage is rarely severe. Serious inflammation is not to be feared although in rare instances there may be infection of the accessory sinuses or of the ears A few cases of meningitis have been reported and one of our patients died suddenly on the second day of pulmonary embolism. It is important therefore to avoid this operation in persons who are known to be suffering from other organic diseases.

The most difficult cases are those in which a previous operation has been badly performed and only part of the obstruction has been removed. In these there may be great trouble in separating the flaps in the region that has previously been treated. The operation can only be performed well by those who have frequent practice and is essentially one for the specialist.

OPERATIONS ON THE TURBINATE BONES

The Inferior Turbinate

The inferior turbinate bone is often enlarged in cases of rhinitis and in the form known as hypertrophic rhinitis its mucous membrane may be so swollen that its surface has a cauliflower like appearance Such enlargements cause obstruction and air can neither enter the inferior meatus nor pass between the turbinate and the septum The same result is noticed with hypertrophy of the posterior ends The slighter forms are generally treated by caustics such as pure chromic acid by zinc ionization or by electro-cautery used either to scar the surface or

better to puncture down to the bone The results of cauterization are not so permanent as those of operation

Partial turbinectomy —The redundant mucosa is trimmed with scissors or if necessary a cut is made through the bone near its attachment and the anterior part of it removed with a wire snare The wire should be strong enough to cut through the bone cleanly To prevent the persistent bleeding that sometimes follows this operation a firm plug of gauze moistened with liquid paraffin should be inserted and left *in situ* for twenty four hours

The posterior end is more difficult to remove on account of its position When cocaine is used the membrane may shrink so much



Fig 689 —Middle turbinectomy

that it cannot be seized by a snare If necessary a groove should be made in the bone in front of the enlargement with upward cutting forceps and the loop inserted into it With a general anæsthetic the first finger can be passed behind the palate and used as a guide for the snare As a rule no plugging is required.

The whole inferior turbinate should never be removed as this may cause persistent crusting rhinitis

The Middle Turbinate

This bone can be amputated without fear either when it is so enlarged or so compressed between the septum and the ethmoidal region that it causes obstruction of the upper part of the nasal fossa Such a condition prevents ventilation of the olfactory region and leads to catarrh and infection of the fronto-ethmoidal cells Amputation is undertaken to open up the ethmoidal region in patients suffering from ethmoiditis or polypi to cure reflex nasal headache or vacuum

headache produced by absorption of air from a blocked frontal cell, and to gain access to the posterior ethmoidal cells and sphenoid.

With cocaine and adrenaline there is less bleeding than with a general anæsthetic Both outer and inner aspects of the bone must be carefully anæsthetized. A cut is then made through the bone with nasal scissors either from before backwards or if the nose is narrow from below upwards to make a groove in the free margin of the bone. The anterior end can be removed quickly with a snare introduced into the groove and with very little discomfort to the patient. It is rarely necessary to take away the whole of this turbinate or to plug the nose afterwards as bleeding is seldom severe. (Fig 689)

OPERATIONS ON THE LACRIMAL SAC

Various operations have been suggested to restore the function of the lacrimal apparatus in patients suffering from epiphora or suppuration of the lacrimal sac. West and D R Paterson about 1908 were the first surgeons to drain the sac directly into the nose claiming that more cases can be cured by this means than by extirpation of the sac through an external incision. Although excellent results have been obtained with nasal drainage most ophthalmologists are still of opinion that there is no reason for allowing the rhinologists to take over the treatment of these cases In skilled hands either method appears to give equally good results (*see* p 1645)

When the trouble is due to suppuration in the anterior ethmoidal cells drainage into the nose is undoubtedly the best method. Either general or local anæsthesia may be employed but a combination of both is preferable. Locally the nasal mucosa should be shrunk with cocaine and adrenaline and the tissues in front of the middle turbinate bone with an injection of novocain 1 per cent and adrenaline 1 in 1 000 By this means the bleeding can be largely controlled and the operation is rendered much easier

Intranasal Dacryocystostomy (West s Operation)

A small flap of muco-periosteum is turned back from the outer wall of the nose with its base in front of the anterior end of the middle turbinate bone as a rule this flap is removed. The tip of the turbinate should be amputated when found to be enlarged. The area of bare bone thus exposed is removed with a chisel a window being formed between the nasal fossa and the orbit The opening is made sufficiently large to expose the inner wall of the lacrimal sac and when necessary the anterior ethmoidal cell is cut away

To control the bleeding which prevents a view of the sac at this stage firm pressure should be employed for a few minutes A probe is passed through the punctum in the lower eyelid and the sac is pressed through the window into the nose so that its nasal wall can be seized with a tenaculum drawn down and freely excised. As bleeding is often persistent this may be a troublesome undertaking

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and in most cases it will be easier and better to open the sac freely by cauterization. The probe is removed and the sac is washed out with a lacrimal syringe introduced through the punctum. This treatment affords good drainage to the sac, and forty-eight hours later all suppuration has usually ceased. In old-standing cases where the sac has become fibrous there is a tendency for the fistula to close, but this can be prevented by occasional passage of a probe or, better, by insertion of a malleable lead style which should be worn for 14 days. No plugging is necessary and the wound usually heals within a week.

External Dacryocystorhinostomy (Toti's Operation)

This procedure is preferred by some surgeons because of the certainty with which the lacrimal sac may be identified and the ease with which affected ethmoidal cells may be exenterated. Under local or general anæsthesia a small incision is made beginning just above and internal to the inner canthus and carried downwards and outwards. By careful dissection the orbicularis muscle is identified and divided, thus exposing the anterior lacrimal crest. Division of the deep fascia just behind the crest will expose the sac lying in the lacrimal fossa. The sac should be carefully freed from its bed and the lacrimal duct divided as low down as possible. The lacrimal bone is then perforated and any underlying sepsis in the ethmoidal system dealt with.

Before opening the cells a flap of mucous membrane should be made in the nose with its base forwards, as in the West operation, and employed afterwards to epithelialize the raw surface. An adequate opening is made into the nose and the nasal aspect of the sac is slit up with fine pointed scissors from below upwards for about a third of its length. The cut margins are everted and anchored with a fine catgut suture. Lastly, the flap of mucous membrane is sutured to the anterior edge of the cut sac.

After-treatment consists in keeping the nose free from crusting until healing is completed, the catgut suture usually coming away on the fifth or sixth day. The sac should also be irrigated through into the nose with a lacrimal syringe until all suppuration has ceased. The cosmetic results are excellent.

Results.—The results obtained with these operations have been very satisfactory. J. S. Fraser reported (1929) 107 West operations; 89 were traced and of these 67 (75 per cent.) were reported as completely successful, the epiphora and suppuration having been cured. Holt Diggle also reported (1931) 79 West operations, of which 68 were traced; 48 (78 per cent.) were completely successful, 6 improved but with some epiphora, and 14 were failures. Toti's reports of successful cases were also very good and rose rapidly from 60 to 80 per cent. As a general rule the most successful results are obtained in patients with large suppurating sacs.

Epiphora alone is more difficult to cure, especially if the canaliculus has been previously slit or enlarged or is not in contact with the

ocular conjunctiva. Even with this complication normal conveyance of the tears may result Also when there is no infection in the sac the nasal opening is very apt to heal again In some instances it may be necessary to apply cocaine and enlarge the opening into the sac with a cautery more than once If this is done properly the percentage of cures may be even higher

OPERATIONS ON THE ACCESSORY NASAL SINUSES

Antrum of Highmore

The maxillary antrum may require exploration for acute inflammation due to infection from the nose or from the teeth chronic sinusitis with or without suppuration necrosis foreign bodies polypi some cases of asthma and migraine or neoplasms either simple or malignant

In all cases the condition of the teeth should be ascertained (if necessary by X rays) and if septic roots are discovered the infected molars or premolars should be removed before an operation is undertaken. In some cases removal of the alveolus may have to be carried out to eliminate residual sepsis. Equally important is the nature of the infection and cultures should always be made as the prognosis depends upon it In many instances other sinuses also are infected, and drainage of the antrum is merely the first stage in treatment.

Exploratory irrigation.—If an infection is suspected irrigation should always be employed first and for preference during an attack because the inflammation may be intermittent and a negative washout may be obtained in the intervals If necessary X rays should also be taken at different stages Even when transillumination shows that the antrum is apparently clear it may be full of purulent discharge or the washout may appear to be fairly clear and yet if examined bacteriologically prove to be heavily infected Blood intimately mixed with thin purulent discharge is usually caused by *a severe hæmolytic infection—streptococcal or staphylococcal.* Such infections cause great congestion of the lining membranes and may be very difficult to cure. When blood alone is washed out the possibility of malignant disease should be considered

In certain instances the normal ostium can be canalized if the middle meatus has been anaesthetized Usually this is not possible and cocaine should be applied to the inferior meatus With a fine trocar and cannula the antrum is punctured high up under the anterior third of the inferior turbinate where the nasal wall is much thinner than at the floor of the nose Either a straight Lichtwitz needle or a curved Myles s trocar can be employed care being taken that the point of the cannula is well in the cavity If the cavity is not entered air or lotion may be forced into the soft tissues and emphysema result in which case the examination should be abandoned The antrum should not be punctured above the inferior turbinate because the

needle may pass into the orbit and infect it When the lotion is forced through the cannula mucus or pus is blown out through the normal ostium If this is closed by inflammation the patient experiences a feeling of pressure and pain in the cheek and the discharge can only be removed by pumping the lotion in and out of the cavity through the cannula

Acute inflammation of recent origin can generally be cured by repeated lavage in this way but chronic infections usually require some form of permanent drainage

Intubation of the antrum—Whereas in adults repeated antral puncture and lavage under local anæsthesia is usually well tolerated in children it is frequently necessary to employ general anæsthesia To overcome this difficulty intubation of the antrum with fine polythene tubing has been employed After the insertion of a Lichtwitz cannula into the antrum via the inferior meatus of the nose a length of polythene tubing narrow enough to pass through the cannula is introduced into the antrum The cannula is withdrawn leaving the end of the polythene tube in the antral cavity The other end is fixed by adhesive stripping to the face By means of a needle inserted into the lumen of the tube regular irrigation can be carried out with a 20 cc syringe without discomfort to the child When the cavity is clean the polythene tube which causes no reaction in the tissues of the sinuses is easily withdrawn

Alveolar drainage—This method is rarely employed except by dentists and the younger generation of surgeons has almost forgotten that it exists Actually it is a very good operation particularly for old and delicate patients and it enables them to use an antiseptic mouth wash and blow it through into the nose as often as necessary Many patients find this less irksome than passing a cannula and washing out the antrum through the nose. The operation is free from risk and causes no shock. The only real objection is that the patient may be compelled to wash out the antrum daily for the rest of his life

Either local or general anæsthesia may be employed When a septic molar is present it should be removed if no molars are present an opening is made through the alveolus into the antrum For convenience this should be in the position of the first molar and the new canal should pass vertically so that a plug of rubber can be attached to a dental plate and inserted easily by the patient

In Desault's operation when the teeth are intact the opening is made through the canine fossa above the teeth and kept open by a small metal plug In either case the plug must be worn permanently

The results are often satisfactory The inflammation quickly subsides and the patient rarely complains of any discomfort or general debility

Intra-nasal drainage.—The great majority of cases suffering from chronic suppuration can be cured by simple drainage of the antrum

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into the nose Under cocaine or gas and oxygen a small opening can be made with a Myles's punch under the inferior turbinate bone into the anterior part of the antrum (Fig 690) Through this opening a curved cannula is passed daily for purposes of lavage To obtain a cure by this means it is essential to restore the normal opening of the antrum the discharge in it can then be easily expelled and air can circulate freely through the cavity When the normal ostium remains blocked the anterior part of the middle turbinate must be removed and the opening into the middle meatus enlarged A lotion consisting of bicarbonate of soda and normal saline (1 dr to 1 pint) is generally employed for lavage but in obstinate cases peroxide of hydrogen flavine (1 1000) or ionization with iodine or zinc-sulphate

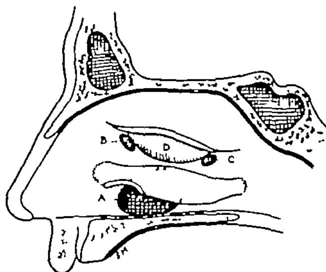


Fig. 690 —Intranasal drainage of antrum.
A, site of new opening opening of frontal duct C, antral ostium; ethmoidal bulla.

solution may be necessary If lavage is to succeed, the character of the discharge begins to change within ten days This failing it is advisable to enlarge the opening under the inferior turbinate so that the cavity of the antrum is thrown freely open into the nose If necessary the linings of the antrum can be curetted through this opening and redundant mucosa or polypi removed

In many instances a small part of the anterior end of the inferior turbinate must be amputated to allow free access to the inferior meatus Free removal of the turbinate is deprecated because of the persistent crusting which may supervene The best results are obtained by securing two small openings near the roof and the floor of the antrum rather than a single large hole under the turbinate. Given careful after treatment quite 80 per cent. of the chronic suppurations can be cured by this method Failure to cure the discharge is often due to infection from other sinuses such as the fronto-ethmoidal and sphenoidal cells.

Radical operations.—These should be reserved for cases which cannot be cured by intranasal drainage for removal of foreign bodies, and for suspected malignant disease. They are more serious undertakings than the intranasal methods and should never be entered upon lightly or without proper consideration of the general condition It is unwise to promise a complete cure in any old-standing infection of the sinuses

Anæsthesia may be local or general. In either case particular care must be exercised to prevent inhalation of pus or infected clots into the larynx during or immediately after the operation

Caldwell Luc operation.—The nose is packed half an hour previously with ribbon gauze moistened with cocaine 10 per cent and adrenaline 1 in 1 000 and the gum and the soft tissues of the cheek over the canine fossa are infiltrated with several drachms of 1 per cent novocain solution containing 10 minims of adrenaline 1 in 1 000 to the ounce The cheek is retracted and an incision is made in the gingivo-labial fold extending from the first molar to the lateral incisor tooth The periosteum is elevated upwards taking care to avoid injury to the infra-orbital nerve and vessels No alarm need be felt if these become visible as they emerge from the bone but damage or undue stretching of the nerve may be followed by troublesome post-operative neuralgia. The wall of the antrum is next opened in the canine fossa with a gouge and mallet the opening then being enlarged to the desired extent with cutting forceps. Care must be taken not to remove bone too freely in a downward direction in order not to interfere with the vitality of the teeth but the opening may with advantage be carried well inwards towards the pyriform angle and well upwards between the infra-orbital foramen and the ascending process of the maxilla in order to secure adequate exposure of the antero nasal wall. Should there be troublesome bleeding at this stage the antral cavity may be plugged for a few minutes with gauze soaked in peroxide of hydrogen or adrenaline thus enabling the surgeon to inspect the mucous membrane and to perform further manipulations such as the removal of polypi of foreign bodies or of a piece of growth for microscopic section. In many cases the next step will be to remove the diseased mucous membrane lining the antrum as it has been shown that a fresh lining of ciliated epithelium will regenerate. The edge of the mucous membrane is elevated from the bone and further separation is secured by small gauze mops until completed. The cavity is dried and any further tags of mucous membrane are removed.

Free drainage into the nose is next established by removing the bony wall of the inferior meatus with a chisel carefully preserving intact the muco-periosteum of the antral wall. The opening in the bone is enlarged well forwards and downwards so that the floor of the two cavities is as nearly level as possible A flap of mucous membrane is turned down from the meatus into the antrum as described by

Bönninghaus thus helping to epithelialize the cavity In many instances the inferior turbinate has already been trimmed and an opening made beneath it at a previous operation. In this case the communication is enlarged by cutting away the partition until level with the floor of the nose The original incision in the mouth can be closed with several catgut sutures to promote rapid healing and to avoid infection from the mouth Although most surgeons prefer not to plug a good result can often be obtained by inserting through the nose and into the antrum a strip of gauze smeared with Bipp

Several modifications of this operation have been advised of which the most widely practised is that of Denker He carries the opening of the antrum forward into the nose to obliterate the recess which is left in the front of the antrum by the Caldwell-Luc operation. Anæsthesia of the teeth is more likely to follow this approach.

The *after-treatment* of these cases is similar to that of simple intranasal drainage but healing may be delayed for two or three weeks and it may be necessary for the patient to wash out the cavity for even longer

With radical operations good results can be obtained and *complications* are rare The danger of osteomyelitis and of meningitis though slight must be remembered especially in cases complicated by multiple sinusitis

ETHMOIDAL CELLS

These cells are a complicated gallery of air-spaces in the lateral mass of the ethmoid communicating with the middle meatus of the nose. Infections of the nose are frequently complicated by inflammation in these cells and operations are often necessary for acute suppuration with high temperature and persistent pain for chronic infections causing persistent discharge and obstruction often associated with sinusitis of the antrum and for nasal polypi.

The following methods of treatment are employed —

Removal of the middle turbinate bone.—Although the availability of potent antibiotics has materially reduced the indications for turbinectomy in the presence of acute infection this operation is still often the first surgical treatment required Amputation of the anterior portion of an enlarged middle turbinate opens the upper part of the nasal fossa and thereby affords drainage to distended ethmoidal cells It also exposes the infundibulum and makes it possible in some cases to wash out the frontal sinus with a cannula. Most cases of acute suppuration in this region not responding to chemotherapy or antibiotics can be relieved by partial turbinectomy

Removal of polypi.—Mucous polypi grow from the muco-periosteum of the ethmoid and are attached either to the middle turbinate bone or to the lining of the ethmoidal cells In their simple forms the polypi are pedunculated and can best be removed by a wire snare. The loop is passed around the polypi as high up as possible tightened, and used to tear them out with their bases of attachment. By this

means the attached portion of the middle turbinate is generally removed When the polypi are very numerous they can be avulsed with nasal forceps more quickly than with a snare. With punch forceps the ethmoidal cells can be opened up and cleared of swollen mucosa and polypi In this operation great care should be observed to keep the instrument against the outer wall of the nose so that the cribriform plate may not be injured To avoid breaking through into the orbit too much lateral pressure must be avoided while breaking down the partition between the cells To obtain a good result it is important to search diligently for concealed cells especially those which are situated far forwards near the infundibulum and posteriorly in the region of the sphenoid. Hæmorrhage may be severe but generally ceases shortly after the operation without plugging

The ethmoidal region must be regarded as a dangerous area where operations should be performed carefully and only by those with experience of intranasal manipulations The complication to be feared is meningitis Considering the number of cases of ethmoiditis that are treated it is surprising that the meninges are so rarely infected but it must be remembered that fatal results have followed even the simple operation of turbinectomy Fracture into the orbit should always be avoided an accident recognized by the resulting emphysema and hæmorrhage into the eyelids Orbital abscess is an occasional complication after intranasal ethmoidal operations

Exenteration of the ethmoidal cells.—For complete exenteration the external operation on the ethmoidal cells follows the line of the external frontal sinus operation of Howarth and others (p 1656) with reconstruction of the divided fronto-nasal duct

Transantral Operation on Ethmoidal and Sphenoidal Sinuses

Indications.—Multiple sinusitis involving the antrum the ethmoidal and the sphenoidal sinuses—as an extension of the Caldwell Luc operation where it is thought desirable to remove hyperplastic or polypoid mucous membrane from the ethmoidal and sphenoidal cells

Technique.—The preparation of the patient and the preliminary steps are as for the radical antrum operation (*see* p 1649) The mucous membrane having been removed from within the antral cavity the ethmoidal system is opened through the postero-superior angle of the antrum by punch forceps entering the posterior ethmoidal group of cells These can now be exenterated backwards to the sphenoid inwards to the attachment of the middle turbinate bone if still present forwards through the anterior group to the frontal angle and downwards to the attachment of the inferior turbinate The removal is effected by punch forceps and curettes The anterior wall of the sphenoidal sinuses having been exposed the ostium may be enlarged

under vision to the required degree by means of upward and downw biting punch forceps great care must be taken in removing upper part of the front wall to avoid injury to the floor of the ant cranial fossa. Bleeding may be encountered from the septal br of the spheno-palatine artery where it crosses the floor of the spheno sinus Some surgeons advocate ligaturing this vessel to ob hæmostasis but it can in nearly all cases be adequately controlle firm pressure The middle turbinate bone is next removed by m of nasal scissors and a snare to complete the ethmoidectomy (Fig 6

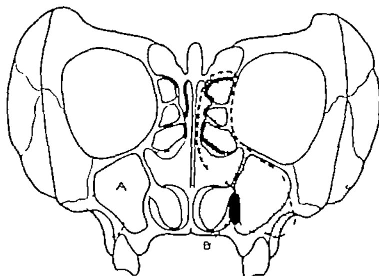


Fig 691 —Transantral removal of ethmoidal sinuses.
A, opening in canine fossa. B, opening below inferior turbinate bone. Area to be removed shade

Some surgeons notably J B Horgan advocate that the mi turbinate should be spared whenever possible in order to preserv valuable physiological properties of moistening warming and trolling the air current In cases which merit an extensive proce of this nature however it is uncommon to find a middle turbi which has not been affected by polypoid changes.

The operation is completed by creating an opening beneath inferior turbinate and suturing the alveolar incision. No pluggi necessary nor as a rule desirable.

The **after treatment** consists in saline irrigations for a short tim remove adherent clots or crusts Persistent crusting is not a trou some complication in spite of the very free removal of tissue when it does occur it is as a rule due to incomplete drainag infected ethmoidal cells

Frontal Sinus

The treatment of infections of this sinus still presents great c culties and much controversy exists as to the best method of obtai relief Operations should only be undertaken after careful exam tions and in all cases X ray photographs are essential.

Intranasal drainage—This method should be chosen whenever possible The middle turbinate bone is often enlarged and pressed against the outer nasal wall thereby blocking the anterior ethmoidal cells which become distended with secretion and polypi Usually the first treatment is removal of this obstruction a cut is made from below through the middle turbinate to its base of attachment selecting a point about the middle of the bone and the anterior end is then amputated with a wire snare The anterior ethmoidal cells if distended should also be broken open after the infundibulum is exposed in this way it is often possible to pass a cannula and wash out the frontal sinus (*See* Fig 690 p 1648)

When a passage cannot be discovered easily it is not advisable to force one it is safer to wait until the swelling subsides With improved drainage the inflammation in the sinuses may subside or if the discharge persists a further attempt may be made to pass a cannula. With careful after treatment similar to that described for the antrum (p 1650) the majority of acute infections can be relieved. But when no passage to the sinus can be found an attempt should be made to dilate the infundibulum To force an instrument from the nose is exceedingly dangerous and if a burr is used to enlarge the bony canal a traumatic stricture invariably results and must be constantly dilated To obviate this difficulty an extranasal method of permanently enlarging the infundibulum has been devised by Harmer

Extranasal operations. **Indications.**—Acute sinusitis with severe toxæmia not responding to antibiotics when complications are feared persistent discharge which cannot be relieved by intranasal treatment chronic purulent sinusitis causing fever persistent headache pain toxæmia and nerve exhaustion recurrent polypi constriction of frontal duct causing vacuum headache mucocele external fistula or necrosis sinusitis with intracranial complications tumours of the fronto-ethmoidal region

Intubation of frontal sinus. **Harmer's operation.**—(Fig 692.) This method can safely be employed for most of the conditions specified above and before the advent of chemotherapy was particularly suitable for very acute types of inflammation Even chronic infections may subside with prolonged intubation

The intranasal tissues are thoroughly shrunk by plugging the nose on the affected side with a strip of gauze moistened with cocaine-and adrenaline solution The eyebrow and forehead are treated with iodine or spirit but are not shaved as the hairs in this region grow very slowly To prevent troublesome bleeding an injection of novocain adrenaline solution should be made into the tissues over the frontal sinus An incision ¾ in long is made below the inner end of the eyebrow dividing all the tissues down to the bone Care should be taken not to expose or divide the supra-orbital nerve for fear that it may afterwards become involved in scar tissue and cause persistent discomfort or

neuralgia. The periosteum is retracted upwards and the whole wound is thoroughly treated with Bipp An opening ¼ in long is made into the frontal sinus above the supra-orbital margin the bone being first perforated by gentle chiselling and the opening then enlarged by a burr or bone-forceps The centre of this opening should lie ⅜ in. from the middle line as this point is usually directly above the upper

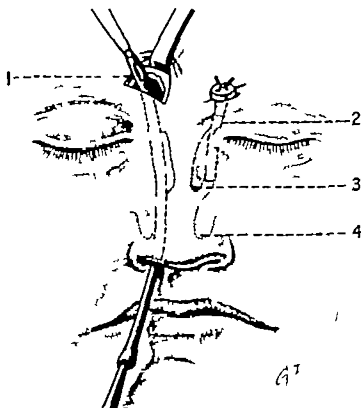


Fig 691 —Intubation of frontal sinus.
1 Catheter dra n through sinus 2, short tube in frontal duct ; 3, middle turbinate ; 4, inferior turbinate.

opening of the infundibulum. The mucosa is then divided and secretion removed from the sinus A fine malleable probe is passed through the infundibulum into the nose and its lower end is seized and brought outside the anterior nares A stout linen thread having been tied to its lower end the probe is withdrawn and the upper part of the thread drawn through the nose out of the wound on the forehead

At this stage or earlier it is advisable to remove the anterior portion of the middle turbinate bone and to open up the anterior ethmoidal cells A soft rubber tube is then attached to the lower end of the thread by means of which it is drawn through the infundibulum and out of the frontal sinus It is essential that the tube should be small enough to pass through the duct without damage to its lining and when the bony canal is very contracted there may be some difficulty both in passing the probe and in introducing more than a

very small tube or thick silk for a few days The tip of the cat cut off and a small piece attached transversely so as to anchor i forehead and prevent it slipping down into the nose (Fig 692 external wound should again be Bipped but not closed by sut it is important to provide free drainage above and below in th stages of the treatment otherwise the wound may become in swollen and painful and recovery may be delayed A ver dressing is needed The operation can usually be compl fifteen minutes and causes so little shock that the patient ca bed in a day or two

After treatment.—In acute cases a cannula should be pass the tube and the wound gently irrigated with warm saline for 10 to 14 days About this period the tube can someti removed but only when the external wound has healed a discharge has completely ceased

With chronic sinusitis it is necessary to intubate for long generally for one to three months After the first 10 days a larger tube can usually be inserted and this should be repe regular intervals the principle being the gradual dilatation by pressure of the fronto-nasal duct without damage to its li discomfort to the patient During the later stages the tube ne be drawn up so that its upper end is lying in the sinus in which is anchored to the forehead by strings passed through and t small circular rubber button. (Fig 692) With this meth wound gradually closes except at the point where the threa out on to the forehead In many cases irrigation through the only required for a week or two but this should be continued as the discharge is copious If the tube is not too large it ca discomfort and the patient can return to his work after a fe

By this simple operation it is possible permanently to di infundibulum Bone absorption takes place around the t straight canal is produced lined with unscarred epithelium wh not contract later after removal of the tube. Given carefu treatment the majority of cases of frontal sinusitis can be cu very little disfigurement

Results.—A report of sixty three patients treated by this showed the following results In 16 cases suffering fror sinusitis pain was permanently relieved in 12 and discharg One patient died of cerebral abscess In 85 cases of chronic pain was relieved permanently in 16 and discharge in 19 The were due to insufficient after treatment involvement of other faulty previous operations and general debility Two patie one of erysipelas two years after operation the other co suicide In 5 cases suffering from pain due to obstructio frontal ducts (vacuum headaches) and in 8 cases of muco obtained relief The operation is a simple one and quite f danger It is far better than the Ogston Luc operation whe

opening the sinus a burr is used to dilate the infundibulum and a tube is inserted With the latter the results were unsatisfactory because when the tube was removed the scarred tissues contracted and a fibrous stenosis resulted

Radical operations.— These should be reserved for cases which cannot be relieved by simpler methods They should only be undertaken by specialists who have frequent opportunities of performing them

External operation with removal of floor of sinus —The operations most commonly practised are those described by Howarth in this country and by Lynch Sewall Ferris Smith and others in America. The technique of these interventions in which the frontal sinus is approached from the orbit with exposure of the ethmoidal system differs only in detail from the procedure described by Jansen in 1894.

Anæsthesia may be either local or general. In the former as practised by Ferris Smith and others in America the nose is packed with ribbon-gauze soaked in cocaine-adrenaline mixture and the skin is infiltrated with novocain adrenaline solution around the inner canthus and supra-orbital region Many operators in this country prefer to combine these measures with a general anæsthetic for the comfort of both the patient and the surgeon

Technique —The eyelids on the affected side are sutured to prevent injury to the eye. A small curved incision three-quarters of an inch long is made through the skin beginning below and just internal to the supra-orbital notch and extending downwards a quarter of an inch mesial to the inner canthus The superior palpebral vessels are ligatured and the incision is carried down to the bone With a sharp elevator the orbital periosteum is stripped upwards to the roof of the orbit downwards to the lower margin of the lacrimal fossa—this displaces important structures namely the pulley of attachment of the superior oblique muscle and the lacrimal sac—and backwards to the anterior ethmoidal vessels and nerve the vessels being ligatured and divided close to their entrance into the bone This is facilitated by a curved self retaining retractor The lacrimal fossa the floor of the frontal sinus and the lamina papyracea of the ethmoid being exposed the mesial orbital wall is perforated and bitten away with punch-forceps preserving if possible three-eighths of an inch of the lower margin The posterior margin of the nasal process of the maxilla is removed with heavy punch-forceps to permit free inspection of the anterior ethmoidal region By means of forceps introduced through the nose the ethmoidal cells are carefully removed back to the sphenoid The middle turbinate is gently levered outwards towards the orbital wall and Grunwald punch forceps are introduced with the female blade along the cribriform plate The bone is punched clearly away without twisting or tearing Any remaining ethmoidal cells are dealt with and if the mucosa covering the nasal roof is diseased it can readily be stripped away by small gauze mops soaked in a solution of

5 per cent picric acid in 85 per cent acetone as practised by Ferris Smith The sphenoidal sinus is opened by introducing a Sluder knife in the ostium which is enlarged sufficiently to admit punch forceps The whole anterior wall is removed care being taken to keep the forceps parallel with the nasal roof when removing the upper margin in order to lessen the risk of damage to the floor of the anterior cranial fossa (Fig 693) As much as required of the bony sphenoidal floor is removed avoiding (if possible) damage to the septal branch of the spheno-palatine artery which traverses the mucous membrane covering the nasal surface of the floor of the sphenoid By elevating

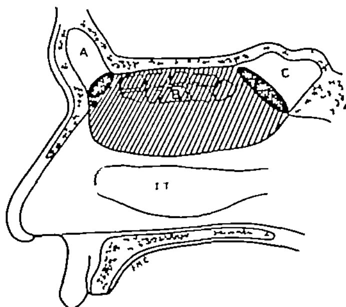


Fig 693 —External operation for frontal sinus.
A Opening into nose B Ethmoidal area to be removed, shaded. C Opening int sphenoid. IT Inferior turbinate.

the mucous membrane it is possible to ligature this vessel before dividing it but in most cases firm pressure with a swab will satisfactorily control the bleeding If the mucosa of the sphenoidal cavity is polypoid it can be gently removed by an elevator or teased out by small strips of gauze soaked in the picric acid solution The floor of the frontal sinus is removed and the cavity inspected with the aid of a small mirror of the post nasal type Any polypi seen should be removed but the rest of the mucous membrane should if possible be preserved intact All fronto-ethmoidal cells are carefully followed up and opened. A rubber or plastic drainage tube is selected sufficiently wide to fit snugly into the frontal sinus One or two windows should be cut in the tube to assist drainage and its length adjusted so that its lower end is just above the attachment of the inferior turbinate bone A piece of oiled silk is then placed over the tube and its upper and lower ends are tucked under the cut edges of the bone. A small Thiersch graft cut from the arm or thigh is placed

on the oiled silk with the raw surface outwards. The graft must be adjusted accurately so that its upper and lower ends are tucked under the bony edges An excess of graft extending backwards along the lamina papyracea is undesirable since it may lead to excessive squamous epithelium formation and consequent post-operative crusting.

The cut edges of the periosteum are approximated with fine interrupted catgut sutures to connect the soft parts with the graft. The skin incision is closed by vertical mattress sutures which are removed on the fourth day The tube and oiled silk are removed on the tenth day after which the patient may be allowed to get up After treatment consists of occasional irrigation with normal saline until the cavity is clean.

Obliteration of the frontal sinus.—The indications for this operation are failure to relieve the patient by less radical measures or osteomyelitis of the frontal bone.

Technique —A curved incision is made the full length of the eyebrow, extending down internal to the inner canthus to the side of the nose. The supra-orbital vessels are picked up and ligatured The periosteum of the frontal wall is elevated upwards with the soft tissues and the orbital periosteum is detached with the contents of the orbit until the floor of the sinus is exposed The sinus is opened by means of a gouge and the anterior wall including the supra-orbital ridge and the floor are completely removed with punch forceps All shreds of mucous membrane are carefully detached from the inner wall of the sinus which should be inspected for areas of infected bone or sequestra Having bevelled off the cut margins of the sinus the soft tissues are brought together and accurately sutured A drain should be left in the lower part of the wound for several days. Firm pressure must be kept up over the flap of soft tissue in order to encourage adhesion between the skin flap and the posterior osseous wall. The cosmetic results after the operation naturally vary with the size and shape of the infected sinus but subsequent insertion of bone chips can do much to improve the disfigurement The functional results are very good.

Complications of external operations.—External operations on the frontal sinus are not free from danger although most complications can now be successfully controlled by chemotherapy and antibiotics. Logan Turner collected the records of 24 fatal cases and many others have occurred

Neuralgia —This is fairly common and may be very serious Sometimes the attacks of pain are so severe as to be intolerable They may last for years and cause mental disturbances. For some unknown reason the depression may be out of all proportion to the local conditions The general health may never be quite as good after radical operations This may be due to involvement of the supra orbital nerve in scar tissue with the formation of painful neuromas These may be injected with 80 per cent alcohol with complete relief

of symptoms for long periods but it is sometimes necessary to excise that portion of the nerve which has been caught up in the scar tissue

Retrobulbar neuritis—This is rare and may result in loss of sight on the affected side

Osteomyelitis of the frontal bone is a serious complication which may arise spontaneously in the course of an infection of the frontal sinus usually of an acute type or may follow external operations The inflammation spreads upwards and outwards along the venous channels of the diploë and at an early stage the skin of the forehead and eyelids becomes œdematous and tender sometimes without any rise in temperature A slight œdema is not serious but when the puffiness is increasing or the bone is sensitive to pressure no time should be lost before the wound is freely opened In more extensive cases exposure is obtained by extending the incision outwards to the external angular process upwards along the temporal crest to a point within the hair line and from there parallel with the line of the hair right back to the middle line. The rectangular flap is turned inwards to give complete exposure of the affected frontal sinus and bone If the infection in the diploë has crossed the middle line the flap may be planned to turn downwards thus exposing the whole of the frontal bone. In mild cases only the outer table and affected diploë are removed, but it is often advisable to remove the whole thickness of the bone down to the dura mater The scalp flap is sutured back in place with drainage. Antibiotics have materially improved the prognosis but even before these became available many successes were reported in the treatment of this condition notably by Von Eicken. Where the condition is at all extensive the prognosis how ever still remains grave

Orbital cellulitis or abscess may also require free drainage

Meningitis may supervene without injury to the cranium but is more often the result of a fracture of the posterior wall of the sinus or of the cribriform region The greatest care must therefore be taken to protect these regions from injury Bipp often prevents the spread of infection

Abscess of the frontal lobe and subdural abscess may develop in any old-standing case of sinusitis with or without operation. Occasionally a radical operation on the frontal sinus fails to relieve the symptoms and a further operation becomes necessary On opening up the wound again the pus may be found to come from a cavity inside the cranium (subdural abscess) and can only be cured by free drainage Abscess of the frontal lobe being in a silent area of the brain may present difficulties in diagnosis and is frequently overlooked until spreading cerebral œdema begins to involve the motor area The abscess may be unilateral or bilateral. In one case after drainage of a small abscess in one frontal lobe there was no improvement and the patient died six weeks later Post mortem a much larger abscess was unexpectedly found in the opposite lobe If the abscess becomes encapsuled it may be mistaken for a cerebral tumour Complete recovery may follow

successful drainage. Most of these complications can now be successfully controlled by chemotherapy and antibiotics

Sphenoidal Sinus

Indications.—Chronic suppuration usually associated with infection of the posterior ethmoidal cells and often responsible for persistent occipital headache and general toxæmia for the relief of certain cases of Eustachian catarrh and otorrhœa chronic pharyngitis (sore throats) in cases of retrobulbar neuritis caused by sphenoidal infection and as one method of exposing a tumour of the pituitary gland

Operation.—The sphenoidal sinus is a cavity of variable size and shape X ray examination particularly after partial filling with a contrast medium such as lipiodol is a very important pre-operative measure because it shows whether the cavity is dense owing to thickening of its mucosa or to discharge Also it reveals any asymmetry such as an extension across the middle line or laterally into the great wing of the sphenoid bone

Exploratory puncture should always be made before any operation is advised to prove whether there is inflammation or not and acute infections can usually be relieved by this treatment alone. The puncture should be made through the lower part of the anterior wall of the sinus and under no circumstance should force be used In many instances a fine cannula can be passed through the normal ostium but if there is difficulty part of the middle turbinate bone may have to be removed to expose the front of the sphenoid sufficiently

With Watson Williams s method the front of the sphenoid is well cocainized The trocar and cannula are passed between the septum and the middle turbinate bone and pushed through the bone with gentle pressure care being taken not to injure the posterior wall of the cavity If the bone is very hard a spot rather farther forward can be tried but those who have not much experience of operations on the sinuses must remember they are dealing with a dangerous region and that after long-continued infection the bones may become softened or brittle The landmarks are therefore very important if the puncture is made too high it may damage the base of the skull or even perforate the anterior cranial fossa. By this means the sinus can be washed out or aspirated and so the presence of discharge and the infecting organisms can be determined

Chronic infections usually require an operation to provide permanent drainage A local anæsthetic is generally preferable as there is much less bleeding than with general anæsthetics and the operation can be performed safely and neatly The greater part of the middle turbinate bone is removed to give free access to the sphenoidal region A Sluder s knife is passed through the normal ostium which is enlarged so that it will admit the blades of a Hajek punch forceps and the anterior wall is cut away piecemeal as low as the thick bone forming

the floor of the sinus and laterally until the whole cavity is as freely opened as possible The cavity can now be inspected When normal the mucosa is pale and looks almost white but when infected it may be œdematous or highly injected and bleed readily when touched Unless the tissue is polypoid the lining membrane need not be removed except anteriorly so that a very free opening is obtained

The outer nasal wall should also be carefully examined and if an enlarged posterior ethmoidal cell containing pus can be found it should be laid freely open with suitable punch forceps.

Complications after this operation are rare but instances of severe hæmorrhage of basal meningitis of injury to the optic nerve and of thrombosis of the cavernous sinus have been reported

The **after treatment** consists in daily lavage and in most cases suppuration ceases quickly As St Clair Thomson says the sphenoid is one of the most satisfactory sinuses to treat But there are cases with heavy infection particularly when complicated with multiple sinusitis or diffuse inflammation of the bones when it may be difficult to prevent cicatricial closure of the opening In these prolonged treatment and further operations may be necessary

OPERATIONS ON THE PHARYNX

Excluding Tumours and Malignant Diseases

Operations on Abscesses

Peritonsillar—With acute inflammations pus may collect in or behind a tonsil (quinsy) but it is often difficult to diagnose and to locate such an abscess If pus is suspected the swelling should be explored A solution of cocaine (10 per cent) should be applied to the tonsil and also to the front of the sphenoid so as to block the external and posterior palatine nerves passing from the spheno-palatine ganglion to the tonsil A strong probe bent at a right angle should be forced through the supra tonsillar crypt in various directions and if an abscess is pricked the sinus can easily be dilated with forceps This is the most reliable method of treating a quinsy If however an incision is preferred a guarded knife or pointed sinus forceps may be used and plunged boldly into the prominent part of the swelling through the soft palate To cure a chronic abscess it is generally necessary to perform tonsillectomy

Retropharyngeal.—Acute abscesses which develop in the loose cellular tissue behind the pharynx usually produce an elongated swelling of its posterior wall In such a case a longitudinal incision should be made into the most prominent part and the abscess drained into the pharynx When under general anæsthesia the patient should lie on his side so that pus may not enter the larynx Chronic abscesses cause firm painless swellings on the posterior pharyngeal wall usually on one side behind the pillars of the fauces Without exploration they may be difficult to distinguish from slowly growing tumours such

as sarcomata They may be due to trauma or foreign body resulting in any form of bacterial or tuberculous infection or cervical caries involving the retropharyngeal glands or prevertebral tissues They can be easily opened by an incision through the prominent part of the swelling in the pharyngeal wall this is a much simpler treatment than an approach through the neck and actually gives a quicker cure in most cases the sinus healing well in a short time even when due to chronic tuberculosis

In some cases especially when there is also a prominent swelling in the neck it may be better to open by an external incision and so prevent secondary infection from the mouth

Operations on the Tonsils

Removal of the tonsils is one of the most frequently required operations of surgery and when adenoids are present they should be treated at the same time. Tonsillotomy namely removal of the prominent part of the tonsil used to be practised for simple enlargement in children under five. The results were unsatisfactory leading in many cases to retention of sepsis in the scarred tonsil remnants. It has therefore been discarded. Tonsillectomy which implies removal of all the tonsillar tissue with the capsule intact is a more difficult undertaking and should only be advised after careful consideration. In recent times it has become so popular that surveys of school children reveal that as many as 80 per cent have had their tonsils removed. As the after results have not always been satisfactory many laryngologists and school medical officers are now adopting a more conservative attitude towards these operations

Indications.—Indications for tonsillectomy include infected tonsils and adenoids in children recurrent tonsillitis or quinsy failure of tonsillotomy and removal of infected tonsillar remains enlarged glands in the neck simple or tuberculous tonsillar sepsis associated with general debility catarrhal infections of naso-pharynx sinuses ears and lower air passages rheumatism certain infections of the lungs heart, kidneys and nervous system goitre malignant disease infections of the eyes or of the gastro-intestinal tract or in fact any form of toxæmia in which it is believed that the tonsils may be sensitizing agents In doubtful cases a bacteriological examination of the secretion from the crypts should be made and if cultures show heavy infections particularly with hæmolytic organisms the tonsils should be condemned

Anæsthetic.—On the Continent and in America local anæsthetics are generally employed but exceptions are made if the patient has a sensitive throat or if he is nervous They should not be employed against the wish of the patient or in children under fourteen To obtain a satisfactory anæsthesia the surface of the tonsil should be painted with cocaine (10 per cent) and the pillars of the fauces and tonsil bed infiltrated with a solution of procaine (2 per cent)

General anæsthesia is preferred by most British people both surgeons and patients The importance of an anæsthetist not only skilled but accustomed to this type of work cannot be too strongly emphasized For guillotine operations in children in out patient departments chloride of ethyl or open ether is in common use Chloroform is not so safe and should never be given alone.

Position.—The patient may be placed in any of the four recognized positions namely sitting in a chair lying on a flat table lying with the head extended lying on the right side The last two are the best, because in these positions blood runs out of the mouth and the breathing is never obstructed. With the patient s head extended the surgeon sits on a stool at the head of the table but in Butlin s lateral position he should sit on a low stool facing the patient with an assistant on his right side to depress the tongue and to sponge out the blood A suction apparatus is also of great value in removing blood and mucus.

Tonsillectomy—The tonsils however adherent should be removed cleanly with their capsules intact Even in experienced hands this may be difficult Having seen and extensively employed many different methods we have come to the conclusion that the following operations fulfil all requirements

Method of Whillis and Sluder—This excellent operation is chiefly employed in out patient departments where speed is essential and is applicable in the majority of cases especially in children. The reverse side of a guillotine with a blunted edge is applied to the tonsil so as to lever it upwards and outwards The handle of the instrument is directed towards the angle of the mouth on the opposite side and firm pressure is applied to it to force the guillotine against the wall of the pharynx thus causing the tonsil to bulge into the anterior pillar and soft palate With the tip of the *forefinger or thumb* the supratonsillar portion of the soft palate and the tonsil are pressed through the opening in the guillotine and steadied while the blade is closed sufficiently to engage the tonsil. It is important to see that the blade passes posterior to the reflection of the mucous membrane behind the edge of the anterior pillar

The finger or thumb must be removed before the blade is pushed home otherwise the palate will be buttonholed A momentary inspection shows that the uvula is free and that the whole tonsil lies on the inner side of the guillotine The blade is then forced home. With a blunted instrument considerable pressure is required but if the vessels are crushed there is less bleeding than when cut by a sharp knife

The tonsil having been removed a sponge is inserted into the fossa by an assistant and pressure is maintained on it for a few minutes while the surgeon examines the tonsil to see that the capsule is complete. The second tonsil can afterwards be removed in the same way

Hæmorrhage is more efficiently controlled if bleeding points are picked up with fine-pointed artery forceps and ligatured. In this manner the first tonsil bed is rendered quite dry before the second tonsil is removed the bed of the latter is treated in the same way

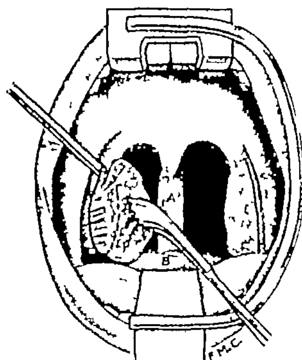


Fig 694.—Enucleation of tonsil with snare. A, Intra tracheal tube B, pharyngeal pack.

Tonsillectomy (by dissection).—This is a more reliable method in adults or in children when the tonsils are very adherent. It has the further advantage that it causes less bruising than the guillotine The tongue being depressed by the assistant the right tonsil is seized with a tenaculum and drawn inwards and forwards from its bed. With a small sharp periosteal elevator the mucosa is divided on the tonsillar side of the anterior pillar around the arch of the fauces and down the posterior pillar These incisions should be superficial and should cut neither the pillars nor the capsule of the tonsil This part of the dissection requires great patience and delicacy and it is most important that the pillars should not be torn or denuded of their membranes or scarring and deformity will result. The elevator is now introduced more deeply behind the upper pole of the tonsil and is swept around it so as to dislocate it from the fossa The tonsil can now be quickly separated from its bed by traction downwards and by separating the tissues with a strip of gauze or by a blunt dissector The lower part being now isolated can rapidly be removed by a wire snare such as Eve s placing the barrel of the snare in the supratonsillar fossa and the loop over the lower end of the tonsil (Fig 694) Sponge pressure is applied temporarily while the tonsil is examined

The parts of the tonsil that are most often missed are the lower pole near the tongue and the superior lobe under the supratonsillar fold If necessary the snare must be used again to remove them otherwise these stumps may give rise to further attacks of tonsillitis or may hypertrophy to such an extent that they fill the fossæ again

After tonsillectomy a careful search should be made for bleeding vessels which may be either veins or arteries. From the former the

blood is dark and wells up rapidly, which makes it easy to detect The arteries in this region being generally small are more difficult to see The blood from them is bright red and spurts across the pharynx in a fine stream splashing the opposite wall Sometimes the fossa

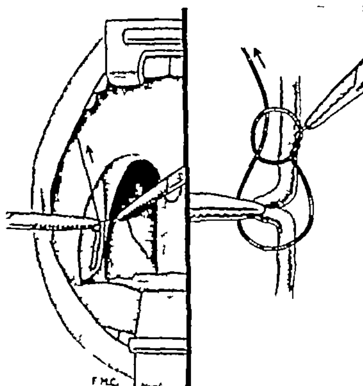


Fig 695.—Ligature of tonsillar vessels (Coakley s knot)

fills so quickly that the site of the bleeding is difficult to determine The cut vessels are often found near the tongue and under the supratonsillar fold The first essential is to prevent too much blood from collecting in the pharynx so that respiration becomes difficult and above all to ensure that blood is not aspirated into the lower air-passages The second tonsil should never be removed until the hæmorrhage from the first tonsillar fossa has been completely arrested *A rule should be made never to allow the patient to leave the operating table until all bleeding has ceased* The better method is to pick up and tie the different vessels with linen threads or fine catgut using the slipknot of Coakley (Fig 695) In rare instances where the bleeding cannot be controlled with ligatures a small swab of gauze should be placed in the fossa and the pillars of the fauces sewn together over it (Fig 696) Only by such means is it possible to save the patients from the distress and dangers of prolonged bleeding

Dangers and complications.—The *anæsthetic* is still regarded by the public as the chief danger of the operation Unfortunately deaths are constantly reported children being the principal victims The majority of these accidents are due to chloroform.

Hæmorrhage may also be alarming after the patient returns to bed but is rarely serious if proper precautions are observed When very severe the patient becomes pale and restless the pulse-rate rapid also there is repeated vomiting of gastric fluid with dark clots and bright streaks of blood. Recurrent hæmorrhage occurs mostly during the first six hours after operation true secondary hæmorrhage resulting from sepsis between the 4th and 10th days. The brighter the blood the more important it becomes to treat the cause. The throat should at once be inspected to ascertain the source of the bleeding Usually a large clot is seen in one or both fossæ or the blood may be coming from the naso-pharynx If the bleeding is getting steadily less and the vomited material darker in colour and smaller in amount the tonsillar clots should not be disturbed

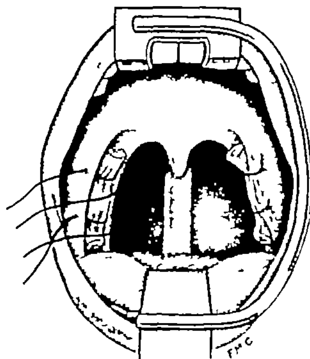


Fig. 696.—Suture of pillars of fauces over gauze pad.

The patient should be kept quiet and if necessary an injection of morphia should be given If hæmorrhage does not cease especially if the patient becomes faint and restless and the ordinary methods such as sitting up sucking ice sponge pressure with pure peroxide of hydrogen or adrenaline have failed the surgeon must never leave the patient or hesitate to ligature bleeding spots or to suture the pillars of the fauces firmly over plugs of gauze. But if the patient is very nervous a second anæsthetic is usually advisable and the pillars should be sutured over a gauze pad with two or more linen threads (Fig 696) If the gauze pad is securely inserted it rarely fails to arrest the hæmorrhage and if Bipp is used can be left *in situ* for forty-eight hours.

Such treatment of the wound is much safer and easier than ligature of the external carotid artery which should be reserved for those rare cases where an abnormally placed carotid vessel has been wounded

Shock should be treated by repeated injections of saline and glucose into the rectum subcutaneous tissues or veins. For persistent oozing such as occurs in bleeders an injection of some form of hæmostatic serum may be given But it must be remembered that usually these are valueless and if the bleeding is serious direct blood transfusion is

essential as it is the only effective treatment and should be insisted upon as long as there is a chance of saving the patient's life

Sepsis.—The amount of inflammation varies unaccountably after tonsillectomy and appears to depend on some personal factor more than upon the degree of sepsis at the time of the operation. The soreness is always localized and apart from the pain is rarely serious nor does it persist for many days except in syphilitic subjects. Referred pain in the ear is common but infection through the Eustachian tubes is fortunately rare as is any other complication

To prevent infection of the throat it is important to treat radically any dental sepsis before the operation to use an aspirator for the blood and so avoid bruising from constant sponging and afterwards to get the patient to rinse the mouth frequently with mild antiseptics. Patients suffering from hæmolytic streptococcic infections should be given sulphonamide or penicillin before operation and afterwards if necessary

REMOVAL OF ADENOIDS

The removal of adenoids one of the commonest operations of childhood is rarely necessary before 12 months of age or after puberty. Although a simple undertaking which can be completed in a few moments the same precaution should be observed as with operations on the tonsils. Except in very young children the two treatments are generally carried out at the same sitting

Indications.—Nasal obstruction causing deformities of the nose mouth teeth or chest persistent catarrh leading to repeated colds laryngitis bronchitis or infections of the Eustachian tubes and ears sepsis resulting in enlargement of glands and general debility reflex nervous conditions such as asthma night terrors convulsions enuresis cough laryngismus stridulus. For these conditions operations give results far superior to any other line of treatment

Anæsthetic.—Either gas-oxygen-ether *or a whiff of chloride of* ethyl followed by open ether is the best anæsthetic. Chloroform alone should never be employed. For highly nervous children a preliminary dose of barbiturate by the mouth is advisable

Operation.—The patient is on his back or turned on to his right side. The mouth being held widely open with a gag a curette grasped in the right hand is passed behind the soft palate as high as possible into the naso-pharynx. The instrument which must be kept exactly in the middle line is pressed firmly against the posterior wall of the pharynx, and the adenoids are removed by making a quick sweep down towards the tongue. If the patient's head is thrown back too far the bodies of the vertebræ may project so much that the knife cannot pass over them easily. For this reason the anæsthetist should be prepared to tip the head forward just before the adenoids are removed. If the cut is made boldly the pad will be caught by the cage and removed *en bloc* with the instrument. Failing this it will

be found hanging by a tag at the back of the throat and must be avulsed. The lateral fossæ are then examined with the finger and tags either scraped away or removed with curved forceps. Care must be taken not to wound the uvula or the pillars of the fauces. Hæmorrhage is usually free and the patient should be turned over so that the blood may run out of the mouth. If necessary continuous sponge pressure can be applied and usually the bleeding ceases. But, more rarely it may be so persistent and severe as to require a second anæsthetic and post nasal plugging No local after treatment is necessary and nasal douches should be avoided for fear of infection of the ears Deafness earache or otitis media may supervene but such complications are rare.

NEOPLASMS

Innocent.—These are usually harmless Thus papilloma adenoma and angioma are often small and easy to remove but if of doubtful nature a biopsy should be made because even a simple wart may be very malignant. If cystic or inflamed the biopsy may be misleading Large swellings above the level of the larynx are nearly always malignant.

Malignant. Rodent ulcer —This basal-celled neoplasm may start in the skin of the nose (27 per cent) on the neck (28 per cent) on the eyelid (17 per cent.) or elsewhere on the head or neck or rarely on the trunk. It may remain inactive for years and then progress rapidly having changed its character and become a squamous-celled epithelioma. Rodent ulcers can be treated with low voltage X rays radium plaques (Beta rays) needles or radon seeds by diathermy or even surgery If properly treated they are nearly always curable. Thus —

Holt Radium Institute 1934–38 1 033 Basal 96 per cent. five-year cures 571 Epidermoid, 80 per cent. five-year cures.

Royal Cancer Hospital 1945–49 500 Basal 90 6 per cent. five-year cures 513 Epidermoid 81 per cent five-year cures.

Unfortunately some patients receive inadequate treatments and recurrences are difficult to cure.

Skin.—Carcinoma of the skin of the nose or face even when extensive usually responds well to the ray treatments mentioned above. Inoperable growths can be benefited by radium (not by X rays) Long and short needles containing 1 to 3 mg can be inserted deeply through the skin into the nose or orbit If a large dose is given the lesion may shrink and necrose. Afterwards it can be removed with diathermy

Squamous carcinoma also originates in the skin or in a rodent ulcer after repeated courses of radiotherapy Eventually it may spread deeply into the nasal fossa, the antrum the ethmoidal cells or orbit.

A small lesion of the inner canthus of the eye was given three courses

of X rays in two years but the whole side of the face orbit and zygomatic fossa became involved The lesion changed to an epithelioma. The wretched woman had a massive and extensive fungating ulcer causing continuous suffering and insomnia. For palliation radium needles containing 80 mg were inserted and retained long enough to cause necrosis Later the debris was removed with diathermy and a denture and shield were made for her face. This enabled her to speak and eat well and she lived for a year—free from pain and sleeping comfortably Such lesions cause great pain and suffering Death is often due to intracranial invasion and meningitis

For some unknown reason such cancers rarely metastasize to the lymph nodes and patients may survive—though suffering pain and misery—for long periods even for 10 or 20 years.

Because of the tendency to recurrence an artificial prosthesis made of soft rubberoid is much safer than rhinoplasty It also looks less unsightly In any case reparative surgery should not be attempted for some years.

Cancers of the Nasal Fossæ and Sinuses

About 8 per cent. of all cancers originate in these regions. They may start in the vestibule floor of the nose or on the turbinate bones more often in the antrum others in the mouth on the alveolus in tooth sockets or hard palate and infiltrating from there into the antrum They also originate in scars caused by lupus or syphilis and notably after repeated ray treatments.

At first there are no serious symptoms but in elderly patients unilateral inflammation discharge bleeding or pain should be regarded with suspicion. When swelling can be seen a biopsy should be made at once but not until the proper treatment can be given. If transillumination shows a dark antrum on one side it should be explored Unfortunately even when the tissue is suspiciously swollen the biopsy may be negative and valuable time will be lost. If clinically malignant the patient should be treated at once. Many patients are given inadequate treatments It must be remembered that there is only one good chance of a cure Usually when first seen the disease is already extensive The sinuses the mouth the orbit the nasopharynx or skin may be involved. In later stages there may be metastases in the cervical nodes lungs liver bones or other parts of the body Ohngren reported 187 patients of whom 84 had metastases in the lymph nodes while Cade reported 80 to 85 per cent with enlarged nodes. Nevertheless treatment is still necessary and palliative measures should be advised for relief of symptoms and to prolong life

Types of neoplasm—There are many different histological types Ewing has described 87 varieties most of them originating in the nasal sinuses.

Carcinoma (70 per cent)—The grading of epitheliomata is difficult but the commonest neoplasm is a squamous-cell poorly keratinized

type which ulcerates early and infects the cervical lymph nodes later

Transitional anaplastic adenocarcinoma columnar cell growths.—These originate in the mucous membranes Adamantinoma is another rare tumour of epithelial origin

Sarcoma. (20 per cent.)—Almost any form of sarcoma found in other parts of the body may originate in the nasal sinuses and at any age They vary greatly in malignancy Biopsy is always required for classification

Group 1 *Osteoclastoma (myeloid) or fibro-sarcoma*.—Slowly growing low grade neoplasms liable to recur but rarely to metastasize.

Group 2. *Chondro-myxo-osteo-sarcoma*.—More malignant and uncertain in behaviour tending to recur locally but not to disseminate.

Both these groups should be treated by electro-surgery and radiotherapy

Group 3 *Osteogenic sarcoma*.—Round or spindle-celled types—common highly malignant and liable to metastasize. These are highly radiosensitive and should be treated with X rays or radium. Surgery is dangerous.

Endothelioma.—This growth occurs between the ages of 50 and 60 Although encapsulated in early stages and growing slowly it has an inveterate tendency to recur and is rarely cured by surgery alone. Nor is radiotherapy advisable as a first treatment. Wide excision with cutting diathermy is better In extensive lesions post-operative irradiation should be advised Even so recurrence is common. When carcinoma supervenes it disseminates to the cervical nodes and later to the bones. Although a very serious disease and difficult to cure life may be prolonged for years

TREATMENTS

Before deciding whether treatment should be curative or palliative the patient s age the condition of the heart lungs and kidneys and the effect of previous illness must be considered. In Great Britain general anæsthesia by the endo-tracheal route is always employed. A blood transfusion may be required during or after operation and as hæmorrhage may be serious preliminary ligature of the external carotid artery should be considered. It is doubtful whether this is performed often enough for it is a simple proceeding and lessens the bleeding greatly also the risk of secondary hæmorrhage. If necessary temporary clamps can be applied to both external carotids. To prevent thrombosis of the common or internal carotid artery the ligature should be applied above the superior thyroid branch

Ohngren reported 88 patients without ligature of whom 37 per cent remained well for three years whereas with ligature in 52 patients 50 per cent. survived for the same period—suggesting that the disease can be removed better when there is less bleeding

Many surgeons now prefer to operate with the aid of controlled hypotension The freedom from bleeding materially reduces the

operating time and may obviate the need for preliminary carotid ligature

To decide whether treatment shall be palliative or curative it is customary to grade these lesions. Thus —

	Primary	*Nodes*	*Expectation of life*
Stage 1	Superficial and localized	None	Good
Stage 2	Infiltrating ulcerated	Unilateral mobile	Poor
Stage 3	Inoperable	Large fixed bilateral	For palliation only

Before describing particular operations the different methods of treatment that are now given must be mentioned. The best results can only be obtained by the correct choice and combination of the following —

Surgery is still very important as will be appreciated later For years wide excision of the maxilla was the only treatment It produced poor results and less than 10 per cent of the patients lived for long During 1900 to 1914 the author did total excision of the maxilla for 25 patients and only two of them lived for three years one of them who had a columnar cell carcinoma lived for 20 years

Electro-surgery —In 1909 surgical diathermy for coagulation of tissues was demonstrated for the first time in England by Nagelschmidt at St. Bartholomew s Hospital. The simplicity of the method the comparatively slight bleeding and the absence of shock were so impressive that it soon became the routine treatment for all growths of the mouth and nose. With coagulation there is undoubtedly less tendency to dissemination and recurrence of disease Three different techniques are employed —

Fulguration —A fine electrode is placed close to but not touching the lesion and when the current is switched on it is sprayed with fine sparks If done slowly the heat does not penetrate for more than a few millimetres The cells are desiccated without burning them Afterwards there is no inflammation sloughing or scarring The method is suitable for superficial warts for keratosis leucoplakia superficial ulceration or fissures due to sepsis lupus or localized recurrent cancer

Endotherm knife —This is employed for excision of growths The needle is moved fairly quickly heat penetrating on a few millimetres Hardly any tissue is coagulated and if necessary the incision can be sutured

Diathermy (electro-coagulation) —When a button electrode is applied to a growth and a current is switched on for 10 to 20 seconds the neighbouring tissues are coagulated and by repeating this treatment even a large lesion can be completely necrosed without bleeding If two small electrodes are used the current passes directly from one

to the other and coagulates a core of tissue between them. Ohngren prefers two particularly for growths in the antrum. Afterwards the tissue can be removed with cutting forceps or a spoon. For circumvallation a long electro needle is passed deeply into the tissues around the lesion and these are slowly coagulated By repeated punctures the whole lesion can be isolated.

It is important to remember that with diathermy the heat extends widely and that if applied for too long it may cause extensive œdema or even sloughing and secondary hæmorrhage if close to important vessels.

After coagulation the wound becomes covered with dry sloughs and takes ten days or longer to heal Usually there is very little inflammation of surrounding tissues. The absence of pain is remarkable. There is seldom any toxæmia or rise of temperature Bone can also be destroyed and if not removed a painless dry sequestrum is produced and will not separate for some months

Radiotherapy (*see* Chap XXV) —Many of these cancers are so malignant that they cannot be successfully treated without radiotherapy Thus for the virulent lympho-sarcoma it is unquestionably the only safe treatment.

Unfortunately many radiotherapists and also some surgeons consider that operations are no longer necessary and that radiotherapy is sufficient. General practitioners certainly do not realize that as a sole treatment it is rarely successful Moreover it is not free from risk and it can be a very harsh treatment There may be serious reactions the skin may be damaged or burnt the eyesight may be affected or destroyed it may cause necrosis of soft or bony tissues anæmia and leucopenia may result causing prolonged illness X rays and teleradium are of great value for inoperable neoplasms but they are essentially treatments at specialized cancer clinics using superlative equipment

Two methods are employed —(1) *Pre-operative* Usually a small dose of X rays totalling 1 000 to 1 500 r is given in three or four days to check mitosis and shrink the growth It is then advisable to operate at once while the disease is quiescent. Some surgeons prefer a full dose and to operate about a month later (2) *Post-operative* treatment is often given to destroy cells that have not received adequate treatment in the hope of preventing recurrence locally or in the cervical lymph nodes Undoubtedly most of these cancers are best treated by a combination of surgery and radiotherapy

Radium plaques are now rarely employed excepting for small superficial lesions such as rodent ulcers Applicators moulded to fit the cavity accurately and carrying 15 to 20 mg of radium are used for cavitary treatment after electro-surgery

Radium needles and radon seeds (*see* Chap XXV) —Interstitial treatment is not practised nearly enough because surgeons do not realize its merits and radiotherapists usually prefer surface applications. For

primary lesions it gives a high tissue dose without affecting the general health or tissues X rays on the contrary may cause so much damage that afterwards surgery for recurrence may be risky With needling ulcers may heal pain and distress may be alleviated hæmorrhage and discharge may be arrested and life made more comfortable An inoperable lesion may shrink and become operable In some cases the lesion is replaced by fibrous tissue which may contain cancer cells Such remnants do not respond well to further irradiation and should if possible be freely excised by diathermy

To determine the exact arrangement of the needles or radon seeds which is required the area to be treated must first be accurately measured and plotted by a physicist To ensure that every part of the lesion receives an adequate dose the physicist must also estimate how long the needles should be retained Immediately after implantation a skiagram is necessary in order to check their position for only by this means can what are called hot spots causing burns and necrosis be avoided Moreover needles in bad positions can be removed and re-inserted

Operations for Cancers of the Nasal Sinuses

Total excision of the maxilla (Langenbeck's operation).—The patient should lie on his back with the head lower than the body With endotracheal anæsthesia this is safe The operation must be performed deliberately without an eye on the clock. The incisions and flaps are the same as in Moure s operation (*see* p 1676) The front of the maxilla is exposed in like manner When dealing with cancer electro-surgery is employed to coagulate all bony tissues and to devascularize them before removal The lacrimal sac is displaced inwards from its groove The floor of the orbit is exposed by drawing the contents upwards. Three cuts are made through the bone with strong bone-forceps or saw (1) Through the nasal process of the maxilla and the nasal bone into the nasal fossa. (2) From the spheno-maxillary fissure through the jaw just medial to the zygomatic prominence (3) After removal of the central incisor tooth and division of the soft tissues along the centre of the hard palate through the alveolar and palatal processes of the maxilla. The soft palate having been detached the maxilla can now be completely removed with lion forceps. Hæmorrhage is controlled by diathermy coagulation and by ligatures The cavity must now be carefully examined so that any tissues which may contain cancer cells can be destroyed by coagulation

For very extensive lesions which have involved the skin and the muscles it may be necessary also to remove part of the nose or face or the eyeball leaving a large cavity A long operation may be followed by severe shock and careful after treatment is essential Usually the wound heals well with diathermy and complications such as sepsis and meningitis are rare If secondary hæmorrhage does occur a general anæsthetic will be needed for its control. Because

of the tendency to recurrence an artificial nose and shield made of soft rubberoid should be fitted but reparative surgery should not be attempted for some years

Actually this operation is rarely necessary now because the following modifications are better and cause far less deformity

Transpalatal operations.—The writer began using the transpalatal approach in 1908 and at first the innovation was received very sceptically But the method soon became popular It has many advantages It affords as good an exposure as the external approach The opening provides free drainage The resulting defect can be covered by a denture which can be removed frequently for irrigation of the cavity There is less tendency to crusting and there is no external scarring and little deformity

It also allows of good inspection afterwards so that any recurrence can be detected and treated early Transpalatal operations are now generally practised. Intimate knowledge of nasal surgery is essential. Good results can only be obtained by complete coagulation of the neoplasm by diathermy Incomplete removal is disastrous

There are three methods

1 **Removal of half the hard palate and alveolus** (Fig 697) —This is employed for unilateral growths of the alveolus palate antrum or nasal cavity also for exposure of the post nasal space To lessen hæmorrhage the canine fossa and the hard and soft palate *should be infiltrated* with procaine and adrenaline With an endotherm needle incisions are made along the canine fossa from the last molar to the central incisor tooth from the latter along the middle of the hard palate and transversely along the junction of the hard and soft palate to the molar region The periosteum is reflected upwards from the out side of the maxilla. The alveolus and hard palate are coagulated by diathermy along the line of proposed division. With a chisel the alveolus is divided between the central incisor teeth behind the third molar tooth and along the middle line of the hard palate

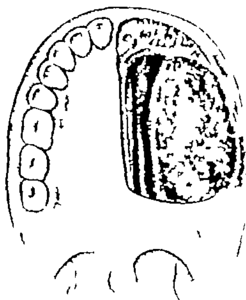


Fig 697 —Transpalatal approach lateral.

The floor of the antrum and nasal fossa is prised away carefully and the opening enlarged with cutting forceps Usually the naso-antral wall with the greater part of the middle and inferior turbinate bones

are excised and after removal of the growth the ethmoidal and sphenoidal cells are exenterated A rule should be made to coagulate slowly all tissues soft or bone before they are removed making sure that



Fig 698 —Skiagram of radium needles on denture.

no pockets are left which may harbour neoplasm When as often happens the growth has broken through the outer wall of the antrum or the infra-orbital plate a much more extensive operation may be

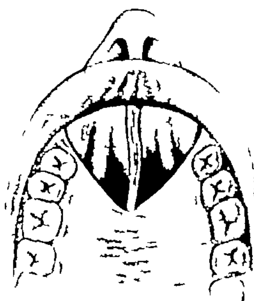


Fig 699 —Transpalatal approach anterior

required including exenteration of the orbit Had this always been realized undoubtedly our results would have been better and there would have been fewer recurrences As Butlin said Regard must not be paid to the deformity that may be caused

Irradiation is often given to deal with outlying malignant cells which may have survived. The following is a method which the writer frequently adopts First pre-operative X rays About 1 000 to 1 500 r are given usually in two or three days. The growth is then destroyed by coagulation After an interval of about a fortnight needles containing 0 5 to 1 mg of radium are distributed on the surface of an applicator which has been accurately moulded for the cavity (Fig 698) Usually about 15 to 25 mg in all with 0·6 to 0 8 mm of platinum filtration are advisable. To keep it in position the applicator is attached to a lead denture which prevents irradiation of the mouth and tongue The applicator is inserted twice daily for two hours night and morning and continued long enough to give a total of 5 000 to 6 000 r thus destroying outlying disease and the cavity should be uniformly filmed

Some surgeons prefer a larger amount such as 50 mg of radium with a 2 mm platinum filter retained for 24 to 48 hours This method is liable to cause severe reaction followed by necrosis and is not entirely free from risk Further it is more difficult to destroy cancer cells by larger does for a short period than when smaller amounts in split doses are used for several weeks.

2. **Wedge shaped removal of front of hard palate (modified Rouge s operation)** —This is employed for growths involving both nasal fossæ or the post nasal space With cutting diathermy an incision is made through the mucous membrane under the upper lip around the front of the maxilla between the first molar teeth A second wedge-shaped incision is made through the alveolus and palate with its apex at the anterior border of the soft palate (Fig 699) With a chisel and forceps the hard palate is then removed and the opening is enlarged. This gives good access to a neoplasm in the nasal fossæ the septum and turbinate bones If these are removed a remarkably good exposure of the post nasal space can also be obtained and a lesion there can be treated with electro-surgery and irradiation

3 **Lateral rhinotomy (Moure s operation)** (Fig 700) —This is employed for cancer in the upper part of the nasal fossa i e in the ethmoidal region or for growths in the post nasal space. Two incisions are made one from the inner end of the eyebrow by the side of the nose around the lateral cartilage and upwards into the vestibule The upper lip need not be divided in the middle line A second transverse incision is made through the inner canthus along the conjunctiva of the upper surface of the lower eyelid as far as the external canthus or if more room is required through this and along the zygoma. This incision causes less disfigurement than one below the eyelid

A flap of skin muscle and periosteum is reflected outwards and downwards to expose the front of the maxilla. A quadrilateral piece of bone is then removed from the front of the antrum and the opening is enlarged with bone forceps so that the extent of the lesion can be determined. The tumour is then removed with electro-surgery

Exenteration of the orbit.—This is necessary whenever the disease involves the contents of the orbit In such cases the orbital plate and its inner wall must be removed The eyelids however should be preserved unless they are involved

With an endotherm knife the conjunctiva is divided all round the orbital margin The periosteum is elevated until the apex is reached

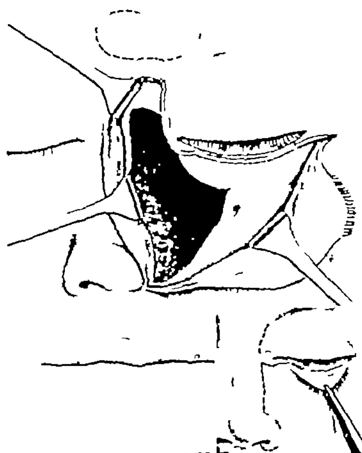


Fig 700 —Lateral rhinotomy

The optic nerve and its vessel are divided and the contents of the orbit together with its periosteum are completely removed

NASOPHARYNX

Fibro-angioma.—This rare growth usually starts at about 14 years of age and may disappear after 25 It originates in the periosteum covering the basi-occipital and basi-sphenoidal bones It may grow rapidly and extend forwards and invade the nasal fossæ the antrum the sphenoidal cells or the orbit or it may spread outwards into the parotid region It is usually incapsuled and has a broad attachment to the base of the skull through which it obtains a very free blood supply Lying in an irregular cavity at the back of the nasal fossæ it is firmly attached and is difficult to remove without free

exposure It may be impossible to ascertain the extent even of an apparently small growth Bleeding can be very severe and fatalities are by no means uncommon Preparation should always be made for blood transfusion during or after the operation

To prevent blood entering the lungs endotracheal anaesthesia is essential and the pharynx must be firmly packed

For a small growth access may be obtained (1) Through the mouth. The soft palate is drawn forwards and the tumour is separated from the

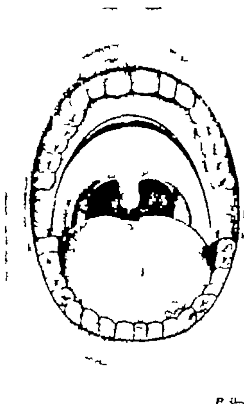


Fig. 701 —Transpalatal approach—posterior The incision.

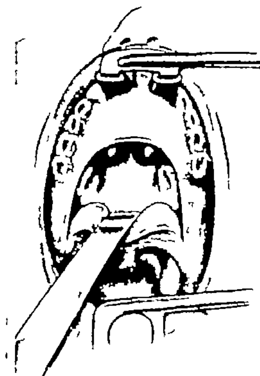


Fig 702 —Transpalatal approach—posterior The soft palate retracted.

base of the skull with a strong raspatory But as this is done blindly it is rarely a safe proceeding (2) A larger lesion requires free exposure. The soft palate and uvula can be divided longitudinally and the flaps reflected laterally To provide adequate exposure part of the hard palate can be removed with bone-forceps. After removal the soft palate can be repaired (3) The soft palate can also be divided transversely C P Wilson* has described this operation (Fig 701) A curved incision with the convexity forwards is made across it from behind the last molar tooth to a corresponding point on the opposite side. To avoid unnecessary bleeding the incision is placed behind

* Proc. Roy Soc. of Med May 1951.

the posterior palatine foramina The soft palate is detached from the maxilla and retracted downwards and backwards The incision is extended laterally to expose the hamular process of the pterygoid plate and the tensor palati tendon If necessary part of the hard palate can be removed This operation gives good exposure of the post nasal space for removal of a fibro-angioma but is not recommended for cancer because if the soft palate is sutured it is difficult to inspect the cavity and to treat a recurrence with diathermy at an early stage.

After radiotherapy repair often fails owing to necrosis of flaps leaving a large aperture which is not easily closed with a denture A transpalatal operation is preferable

Lateral rhinotomy (*see* p 1676) —This can also be employed for removal of a large angioma causing external swelling and deformity (frog face) and if pulsating temporary ligatures or Crile s clamps should be applied to one or both external carotid arteries before attempting removal This is a wise precaution for an operator without previous experience of these cases After free exposure the tumour is carefully separated from its cavity and the base of its attachment defined. With an endotherm needle it is separated from the base of the skull as rapidly as possible At this stage without induced hypotension or ligation of the carotids there may be profuse hæmorrhage and firm plugging is needed to control it Later this is removed quietly and all bleeding vessels are clamped and sealed with diathermy or tied with catgut. The cavity is then inspected to make sure that the whole tumour has been removed. Sometimes the base of the skull is eroded and part of it may come away with the lesion exposing the dura mater which however is rarely involved.

When the cavity is quite dry sulphanilamide powder is insufflated and it is firmly packed with gauze soaked in flavine or smeared with Bipp in liquid paraffin The flap is then sutured in its original position. In a day or two the gauze can be gently removed stopping when the wound starts to ooze Usually in four days it can all be removed and secondary hæmorrhage is rare Should this occur a general anæsthetic will be needed for its control. The outlook is good unless the angioma has been incompletely removed but a recurrence should be destroyed by coagulation at once

A fibro-sarcoma in this region is difficult to distinguish from a fibro-angioma. It is a serious condition which readily recurs is more difficult to cure and requires post-operative irradiation

Cancers.—The treatment of neoplasms in the nasopharynx is a difficult problem When first examined the majority of patients have metastases in the cervical lymph nodes They can rarely be cured and few survive for more than three years Fortunately they are comparatively rare tumours There are many histological types. Amongst 100 patients Ewing found —

Transitional celled	87%
Squamous celled	80%
Lympho-sarcoma	15%
Lympho-epithelioma	11%
Uncertain histology	7%

(78 per cent. of these had metastases in the cervical nodes.)

Discussing the treatment Cade says Surgery is useless and dange ous and adds Radiotherapy is more effective, safer and gentler Most carcinomata and sarcomata should be treated with X rays (teleradium But intracavitary radium can also be combined

Four 10 mg tubes with 1 mm platinum filtration can be place in a rubber catheter and inserted through one side of the nose int the naso-pharynx and then drawn back through the other side s *that the tubes lie horizontally in a semi-circle. The tubes can l* retained for 10 hours daily until a dose of 5 000 to 6 000 r has bee delivered With split doses less reaction is produced and bett results obtained than with large doses for short periods If surfac irradiation is used concurrently the internal dose must be reduced.

On the other hand a low grade carcinoma or fibro-sarcoma may n respond well to irradiation alone Transpalatal exposure and di thermy for removal of the primary growth may give better results.

Radium needles *containing 15 to 20 mg with 0 6 or 0 8 mm.* platinu filtration on an applicator can be inserted through the opening int the naso-pharynx twice daily for 2 to 4 hours until a dose of 5 000 or more has been delivered In this manner an accurate contac dose can be given and if the result is satisfactory the nodes can l treated with X rays or by block dissection

TONSIL

Cancers may be carcinoma (squamous celled or anaplastic) sarcom (lympho or reticular) fibro-sarcoma or endothelioma. Although mos of these are very malignar and radiosensitive they a easier to cure than simila lesions in the naso-pharyn X rays or teleradium bot for primary and secondar nodes are the best treatmen for most types. Unfortu nately there are too fe Cancer Clinics with goo enough equipment. Withou it the general hospital canno expect good results

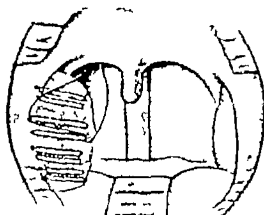


Fig 703 –Radium needling of tonsillar growth.

For the primary lesion sur gery alone is very rarely adv sable but two other methoc are occasionally used —

1 **Interstitial radium needles or radon seeds** (Fig 703) —Ten or more 1 mg needles with 0 6 or 0 8 mm platinum filtration are inserted for 5 to 10 days To prevent slipping they are arranged in pairs with their points in opposite directions—one string of each being tied and cut short The second is left long and brought out of the mouth or through the nose and fixed to the skin with stripping

2 **Electro-surgery** —This is a much better treatment for a low grade primary lesion than is generally realized Even an extensive growth involving the pillars of the fauces the palate the side of the tongue and adherent to the jaws can be successfully excised.

Laryngo-Pharynx

In these situations nearly every neoplasm is malignant and innocent growths are uncommon The usual lesion is a squamous poorly keratinized carcinoma which is seldom localized or encapsuled and is usually ulcerated When first examined the patient has enlarged *nodes in the neck more often than not*

A biopsy is imperative but negative reports are unfortunately common and should not be misleading

These are indeed some of the most difficult cancers in the body to cure but for some unknown reason their virulence varies greatly in different parts of the pharynx

Treatments

Surgery **Median pharyngotomy** —A transverse skin incision is made over the hyoid bone The platysma omo-hyoid and sterno-hyoid muscles are divided The pharynx is opened above or below the hyoid bone *and if necessary this is removed Except for growths* on the upper surface of the epiglottis which can be treated by other methods it gives inadequate exposure and so it is rarely performed

Lateral pharyngotomy (Fig 704) —Trotter deserves great credit for pointing out that the lateral route is superior to any other and exposes the pharynx from the palate to the œsophagus

To obtain access to the tonsil the fauces and the base of the tongue the mandible can be divided in front of the masseter (rarely necessary) The superior constrictor muscle is divided in front of the tonsil. The greater cornu of the hyoid bone and the ala of the thyroid cartilage are removed The middle and inferior constrictor muscles are divided also the aponeurosis of the pharynx. This gives access to the upper part of the pharynx including the tonsil pillars of the fauces the palate and the base of the tongue The extent of the growth can now be determined If it extends downwards to the pyriform fossa a much wider exposure is necessary well beyond the limits of the growth

The dissection of the side of the neck is made as follows Two incisions are required one along the anterior border of the sterno-mastoid muscle from the mastoid process to the clavicle the second

from a point below the chin along the lower border of the mandible to join the first incision. The sub-mandibular and anterior triangles are exposed. The posterior belly of the digastric muscle and mylohyoid muscle are divided and the sterno-mastoid muscle is removed. The common facial vein the superior thyroid lingual and facial arteries are exposed and ligatured and the internal jugular vein is also tied near the base of the skull and low down The superior laryngeal, lingual and hypoglossal nerves are divided but the last should be resutured. The infra-hyoid muscles and the middle and inferior constrictors are detached The greater cornu of the hyoid bone and the

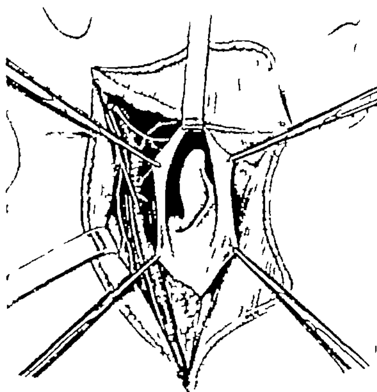


Fig. 704.—Lateral pharyngotomy Trotter's operation.

thyroid ala are removed. Enlarged lymphatic nodes are isolated and included in the block dissection to be removed with the side of the pharynx

The lateral wall of the pharynx is incised well away from the growth and the opening is enlarged enough to determine its extent If sufficiently localized it can then be excised cutting through the normal mucosa at least an inch away from the margin of the growth. In some cases a temporary tracheotomy is advisable. For feeding an œsophageal tube is passed through the nose The skin flaps are accurately united and the wound is drained above and below with tubes which are retained for a few days.

The results of Trotter s operation were disappointing In 71 patients the average duration of life was only 18 months However about 10 per cent of them lived for long periods It soon became apparent that better results could only be expected by much more extensive operations

Pharyngo-laryngectomy—Although this is a mutilating operation it has been found that improved survival rates can be obtained in cancer of the hypopharynx by removal of the affected portion of the pharynx together with the larynx and cervical lymph nodes on the affected side in one mass Bilateral block dissection may have to be carried out but one jugular vein must be preserved The operation may be completed in one or more stages

One stage operation.—A wide flap is used with its base superiorly at the level of the hyoid bone and its lateral incisions placed to give access to the sterno-mastoid muscles on both sides They are united below by a curved transverse incision with convexity upwards The operation proceeds as for total laryngectomy with block dissection of the cervical lymph nodes but includes resection of a segment of the pharynx and upper œsophagus The tracheostome is fixed to the skin and a large bore funnel shaped plastic tube which has been com pletely surrounded with a Thiersch graft is placed in the bed of the excised pharynx with its upper wider end reaching up to the base of the tongue and its lower end in the severed œsophagus The skin flap is then fixed back into place firmly against the raw surface of the skin graft by anchoring sutures on each side to the prevertebral muscles and the incision is then closed. Feeding is carried out through a Ryle s tube introduced via the nose through the lumen of the plastic tube until the latter can be withdrawn at the end of three to four weeks. In a successful case an epithelial lined pharynx results with a lumen which permits of easy swallowing but some stenosis is not uncommon necessitating the passage of bougies at intervals until the tendency to stricture formation is overcome The advantage of this one-stage repair is that the patient whose tenure of life is probably limited is spared two or more plastic operations necessitating some months in hospital before he is relieved of the discomfort of an open pharyngostome

Two-stage operation.—A large rectangular flap with its base to one side as described by Wookey is reflected to expose the larynx and upper rings of the trachea It should include subcutaneous fat and platysma muscle To safeguard the blood supply to the flap the upper half of the sternomastoid muscle should be preserved but the lower half may be removed to expose the carotid sheath if block dissection of the lymph nodes is intended The lobe of the thyroid gland is removed on the side of the lesion After the larynx and pharynx have been freed excision is planned to include a margin of at least ½ inch of healthy pharynx above and œsophagus below The severed trachea is brought out below the flap through a separate incision in the skin of

the sternal notch and fixed to project about ¼ inch above the surface. Reconstruction is started by suturing the flap to the prevertebral fascia and to the posterior margins of the pharynx above and the œsophagus below Anteriorly they are united to the skin thus leaving an open gutter out of which to construct the pharynx at a later stage. Any raw surfaces left in the neck are covered by a skin graft taken from the thigh Feeding is carried out through a nasal tube. Constant care must be taken to keep saliva from the tracheal opening, to avoid pulmonary complications After removal of the stitches the introduction of Gluck s funnel-shaped tube may help to keep the wound dry and permit of the swallowing of liquids The gutter in the neck can usually be closed by simple inturning of flaps 6 to 8 weeks later when an adequate collateral circulation has been established but sometimes pedicle flaps have to be brought up to cover the defect, necessitating further operations

Repair operations.—Repair can be performed at the same time or at a later date In the first case after the growth has been excised the fistula can be closed completely by skin flaps from the neck or by a pedicle flap from the upper chest Drainage tubes should be inserted and retained for two or three days When the patient s condition is not considered good enough the fistula can be left open and a feeding tube inserted. About six weeks later when it has contracted a repair operation can be performed to close it Whenever possible the repair should be made at the first operation.

Irradiation.—Surface treatments with X rays or teleradium are given extensively but as sole treatment with very poor results. Excepting for cancer of the tonsil which for some reason responds well to these treatments the results have been disappointing only 5 per cent. to 10 per cent. of patients being cured It can be stated therefore without question that radiation should be reserved for palliation or for post-operative treatments

The Cervical Lymph Nodes

Patients with secondary deposits in the lymph nodes can seldom be cured and yet many practitioners do not realize this. Some even remark that they do not suspect cancer because there were no enlarged glands. The following plan of treatment is advisable —

1 **No palpable nodes.**—In some regions such as the nasal sinuses cervical metastases are so rare that no surgical treatment is necessary The neck should be examined monthly for a year and afterwards at longer intervals

2. **Nodes not clinically involved.**—If numerous small mobile nodes can be felt they are probably innocent and can be watched. Biopsy is of little value Prophylactic block dissection should never be performed. The Royal Cancer Hospital, the Holt Radium Institute and

most other centres in this country have all given it up The Memorial Hospital New York in an immense statistical analysis of the sort in which the Americans excel have concluded that prophylactic block dissection is both unnecessary and unjustifiable

3 **Nodes clinically involved** —These are much more difficult to cure by radiotherapy than the primary lesions and surgery is the better treatment If mobile and unilateral a complete block dissection should be performed (if it has not been done at the time of the original operation) granted that the primary lesion has been successfully treated and the expectation of life is good. If the dissection is considered to be incomplete post-operative irradiation should be given or radium needles or radon seeds should be inserted

4. **Multiple bilateral fixed nodes.**—These cannot be excised successfully and palliative block dissection should not be attempted X rays are rarely beneficial but blind radium needling or radon seeds may shrink the nodes temporarily prevent fungation and afford some relief from pain

RESULTS

When assessing results it is necessary to know what selection of patients has been used and if palliative treatments are included also to distinguish between those published by the best equipped Cancer Centres and those from General Hospitals using indifferent apparatus The latter of course cannot compete For these and other reasons it is impossible to get anything more than a very rough idea of the actual results of these treatments An endeavour has been made to assess reports which vary greatly by analysing about a thousand cases in each of the main anatomical sites and quoting the average percentages of survivals that are reported It will be noticed that in certain situations cancer is more easily cured than in others for instance in the larynx better results can be obtained than in any other part of the body except for the skin. On the contrary in the pharynx the results are still very unsatisfactory

Nasal sinuses. *Table* 1 —This gives the results of 165 patients most of whom had very extensive cancers treated by the author and his colleagues with three-year survivals —

Carcinoma (124 patients)	30%
Sarcoma (30 patients)	34%
Endothelioma (11 patients)	55 5%

Reports from other well known clinics of over 1 000 patients were better Many were five-year survivals They averaged Carcinoma 40 per cent. sarcoma 50 per cent but with enlarged lymph nodes only 10 per cent

should extend along the anterior border of the lower two-thirds of the sterno-mastoid whereas in spare subjects one of half that length or even less will suffice In any case it must be centred about the level of the cricoid In dealing with pouches of moderate size experienced surgeons with a view to the cosmetic result may prefer a transverse incision following one of the natural folds but this is not recommended for general use

After making the skin incision the platysma and deep fascia are divided and the anterior border of the sterno-mastoid is defined. The left pretracheal muscles are *drawn towards the middle line and* at a deeper level the thyroid gland The pouch will be found between the trachea internally and the common carotid sheath on the outer side. The omo-hyoid muscle can usually be retracted downwards out of the way or the pouch may be enucleated behind it but with a big pouch the muscle may be an embarrassment and should be divided and later re sutured or the ends left retracted Some small arteries and the middle thyroid vein may have to be caught and divided. As a rule the inferior thyroid artery can be stripped aside but in dealing with large pouches it may have to be divided. Sometimes the pouch is not easy to identify and good retraction of the sterno-mastoid careful hæmostasis and good illumination are essential

Usually the pouch can be separated by blunt dissection but there may be some fixation as the result of infection and the knife or scissors may have to be used cautiously The very large pouches may extend into the mediastinum but they can usually be readily withdrawn the process of enucleation being assisted by the finger When a large pouch cannot be satisfactorily mobilized it may be necessary to make a corresponding incision on the opposite side of the neck in order to assist the separation These pouches are not only thin walled but friable and they should not be grasped with toothed forceps a ring forceps like a small sponge handle is the best instrument. The position of the recurrent laryngeal nerve must always be borne in mind and rough handling and the blind use of forceps are both to be avoided.

Notes on the operation of excision.—The pouch is freed and the attachment of its neck to the œsophagus is completely exposed and defined. If small, the neck of the sac should be ligatured. When the opening is large it should be clamped before the sac is removed or if this is impossible the neck should be divided and closed by suture a small section at a time. While the division of the neck of the pouch and the suturing is being carried out the cellular tissue must be carefully protected against infection by gauze packing soaked in antiseptic. Two layers of sutures should always be employed one fine and continuous to close the opening in the mucosa, and the *second of interrupted sutures to bury the first* by a covering of pharyngeal muscle The tissues are soft and friable and must be gently handled. The sutures of fine chromicized catgut should be

passed with a small round needle and must not be drawn too tight or they cut through Any cellular tissue in the vicinity should be laid over the closed incision and either tied in position with the long ends of some of the second row of sutures or fixed with a separate stitch or two The depths of the wound should be lightly dusted with one of the penicillin sulphonamide powders Irrespective of the type of subject or the condition of the pouch a soft rubber drain must always be brought from the depths of the wound to the surface and must not be removed sooner than four days after operation A voluminous dressing should be applied to act as a support for the head and neck.

Swallowing in small quantities may be allowed from the first but may be very painful for about twenty four hours Soft solid food should not be allowed sooner than a week after the operation. Some surgeons feed the patient through a Ryle s tube for the first four days and do not allow solids for three or four weeks If the œsophagus has been carefully sutured the parts usually heal without trouble and in any event the track to the surface provided by the rubber drain is a safeguard against spread of infection towards the mediastinum. If the wound in the gullet has not been effectively sutured or if it breaks down a fistula forms If the whole wound does not break down as the result of infection and if the parts are kept clean a moderate sized fistula tends to heal spontaneously In other circumstances a large fistula may form not only with constant discharge of saliva but with escape of everything taken by the mouth and as a result the patient rapidly goes downhill. The proper treatment is to feed the patient by stomach tube thrice every twenty four hours and to keep the wound as clean and dry as possible As an aid the patient should lie on the left side with the foot of the bed slightly elevated Continuous suction may also be useful If these measures do not lead to rapid improvement gastrostomy is indicated and some intravenous nourishment or blood transfusion may be necessary Attempts at closure by local interference are not likely to help and may make matters much worse

This method of primary excision used to be attended with a high mortality from leaking and mediastinitis and on that account a two-stage operation was devised and is still sometimes practised

Two-stage operation (Goldmann)—The sac having been freed is drawn outside the wound and fixed by sutures to the muscles and skin all round the neck. It should be drawn as high as possible so that its mouth is directed downwards The greatest care must be taken not to puncture the pouch near the neck. If the patient is very weak from want of nourishment the fundus may be punctured after closure of the wound and a small rubber catheter inserted several inches into the gullet for feeding secured by a circular ligature Ten days later the neck of the pouch will be firmly adherent to the surrounding tissues and its superficial part can be clipped away with

scissors or excised with the diathermy needle without any anaesthetic. The mucosa and skin margins are turned in and united by two layers of sutures. Even if it cannot be accurately sutured the cut surface soon retracts and closes. The remaining wound usually heals quickly and without fistula. At the second stage some surgeons carry out a submucous resection of the sac, ligature it off and suture the outer walls. These operations are safe and applicable to cases in which the sacs are large enough to be brought to the surface without tension. Surgeons who have not had great experience of these cases *should adopt this method whenever possible and so avoid the* dreaded complication of sepsis and mediastinitis.

Frank H. Lahey advocates operation even for very small diverticula if associated with symptoms. In these cases the sac is too small to be brought up to the skin surface and at the first operation it is thoroughly separated and displaced upwards, i.e. so that the mouth points downwards, and is fixed to the prethyroid muscle with sutures of fine black silk. The wound is then closed with a cigarette drain down to the sac. Ten days later the wound is re-opened and the black silk acts as a guide to the sac, which can readily be re-separated and removed, while under gentle traction the muscle about the neck is incised down to but not into the mucous membrane. The latter then forms a sort of pedicle which is ligatured with chromic gut and the sac is cut away. The stump of ligatured mucous membrane retracts into the muscle-sheath. A drain is brought from the neighbourhood of the stump and the incision is sutured. As the cellular planes have become sealed between the first and second stages there is very little risk of infection. A small fistula occasionally results but heals readily.*

After any method of operation the patient may complain of slight difficulty in swallowing and this may be the result of narrowing at the site from which the pouch originated. As a rule the trouble soon disappears, but it may be necessary to pass a bougie at increasing *intervals for as long as a year after operation.*

Results.—Excision in one stage is now giving very good results, *immediate and remote.* Morley* had no deaths in 21 cases, Shallow 4 deaths in 99 cases. Leakage during healing or fistulæ are now rare events. In 1937 Lahey (*loc. cit.*) reported on 82 cases operated in two stages with only one death and that in a man of eighty-five. He gives the after-history of 53 of these cases operated upon over two years with the following results: 2 failures (i.e. recurrences), 2 poor results and 49 good results.

These results are in accord with the practice of competent surgeons.

Pharyngopexy, Hill's operation.—The sac, having been exposed as before, is completely freed from the tissues at the lower part of the neck, turned upside down and fixed in that position. This operation, described in previous editions, has now been almost entirely discarded. It is not recommended but may have a place in

* Morley reported three severe and one slight fistula in a series of 21 operations.

very exceptional circumstances as when an intended excision has to be abandoned and the operation hastily concluded

Gastrostomy—This treatment should be reserved for patients who are so old and feeble that they are not considered strong enough for operations on the sacs It should only be performed if they are unable to swallow with comfort enough fluids or soft food for adequate nourishment. On the other hand it may be most valuable as a preliminary to the radical operation rather than an alternative and at any subsequent time excision of the pouch can be carried out if the general condition permits

CHAPTER XXX

OPERATIONS ON THE LARYNX AND TRACHEA

By S E. BIRDSALL

LARYNGEAL OPERATIONS BY INDIRECT LARYNGOSCOPY

LARYNGEAL conditions can be approached surgically either via the mouth or via incisions in the neck there being now very general agreement on the indications for the route

Until the introduction of direct vision laryngoscopy the oral route was only suitable for the relief of conditions involving very little tissue the treatment of which would not be likely to cause much bleeding or much distress to the patient under local anæsthesia. Killian s direct vision method greatly increases the sphere of usefulness of operations carried out via the mouth and is almost equally suitable for general or for local anæsthesia. A description of this method will be found on p 1784

Indirect laryngoscopy is suitable for the application of caustics or of the electro-cautery to granulations also for the removal of small innocent tumours of which the commonest are the small cystic swellings on the edges of the vocal cords usually known as fibromata and found histologically to be fibromata undergoing cystic or myxomatous degeneration Papillomata are still occasionally removed by this method but as they are now believed to be infective it is not surprising that they recur frequently A case is on record in which 200 operations were performed

Other procedures suitable for this technique are operations upon cysts of the epiglottis scarifications of œdematous mucosa carried out with a guarded knife curettage of tuberculous ulcers and removal of foreign bodies which are not too large or too firmly impacted

The operator wears either a forehead lamp or a laryngeal reflecting mirror and directs a beam of parallel or converging rays on to a warmed mirror about ¾ in. in diameter held firmly upwards and backwards against the patient s soft palate by the surgeon s left hand. The tongue grasped in a handkerchief is held fully protruded in the right hand of the patient who is told to breathe silently and slowly through the widely opened mouth

The appropriate sprays probes and other instruments are many but have this in common they all have an approximately right-angled curve the distal limb being about two inches in length and the proximal limb about eight inches A malleable probe has great advantages.

Operation.—The larynx is sprayed with equal parts of 10 per cent. cocaine hydrochloride and 1 in 1 000 adrenaline and when somewhat numbed is painted in the required region with a firmly held pledget

of wool moistened with adrenaline 1 in 1 000 and dipped sparingly into crystals of cocaine hydrochloride so that they dissolve When removing an intralaryngeal growth the surgeon sits facing the patient The mouth is opened to the fullest extent the tongue drawn well forward and held by the patient s own right hand and the mirror introduced If the epiglottis overhangs it can be drawn forward with forceps in rare instances its upper margin has to be transfixed and retracted with a thread the latter being grasped and kept taut by the weight of a pair of pressure forceps allowed to hang freely

The laryngeal forceps is warmed and taken in the right hand when the tumour is on the right side of the larynx, and in the left hand when the tumour is on the left Introduction is difficult and no description however minute will obviate the necessity for oft repeated attempts. Suffice it to say that guided by the reversed image in the mirror the operator avoids contact with any part of the fauces and pharynx until the growth is reached

When the point of the instrument is seen to rest upon the growth the blades are opened and the tumour is grasped and avulsed with careful manipulation there is little danger of wounding the normal mucosa and hæmorrhage is insignificant. If there are multiple growths the patient must understand that it may be necessary to repeat the operation either immediately or after an interval. Given suitable instruments sufficient experience and a tolerant patient it is possible with the help of cocaine to remove the majority of small tumours. With modern anæsthesia, especially with the added relaxation obtainable by the use of curare direct laryngoscopy is most often performed in order to remove simple tumours and granulomata.

After-treatment —The most important aspects of the after treatment should have received attention beforehand Many laryngeal troubles are merely results of infective processes in the upper or lower respiratory tracts and treatment of the larynx alone—as for example the cauterization of tuberculous granulations without treatment of the lungs—is foredoomed to failure

If the accessory nasal sinuses teeth and tonsils have been rendered healthy beforehand laryngeal wounds will be found easy to treat *Vocal rest and prevention of coughing* are imperative and to this end the larynx may be sprayed four hourly with a solution containing equal parts of 10 per cent cocaine hydrochloride and 1 in 1 000 adrenaline The patient is given ice to suck or lozenges of cocaine and krameria and cold compresses are applied externally Inhalations of menthol or of the various balsams may be acceptable while syrup of Virginian prune and small doses of codeine are useful as general measures in the prevention of cough.

DIRECT LARYNGOSCOPY

In the diagnosis of laryngeal disease indirect laryngoscopy remains the first and the most valuable procedure but for laryngeal minor

surgery and for the removal of foreign bodies it has been superseded by direct laryngoscopy The technical advances in electrical illumination have made possible the evolution of the modern laryngoscope with its small high powered lamp The instruments most commonly used by the laryngologist are the laryngoscopes of Chevalier Jackson and their modified forms devised by V E Negus The essential difference between the Jackson and the Negus instruments is that in the former the source of illumination is a small lamp carried on an elongated lamp-holder which is sheathed in a tube incorporated in the whole length of the speculum in the Negus instrument the illumination is provided by much larger lamps contained in twin tubular compartments set transversely at the proximal end of the laryngoscope their long axes converging so as to focus the two beams of light immediately beyond the distal end of the instrument so that when in use the maximum intensity of illumination falls upon the part of the larynx being inspected The greatest advantage of the Negus instrument is the freedom from fouling of the lamps with blood and secretions which often occurs with the single distal lamp of Jackson s instrument

Anæsthesia.—There is no doubt in the author s mind that in the majority of cases direct laryngoscopy is best performed with the aid of local anæsthesia Exceptions are made in individual cases and a general anæsthetic is preferable in some e.g where diathermy or galvanocauterization is contemplated or with extremely nervous patients or in patients whose dental and oral structure entails the use of considerable manual pressure in order to render the larynx visible or where the endoscopic procedure is likely to be prolonged It is extremely important to emphasize the fact that under no circumstance whatever is it permissible to employ an inflammable anæsthetic substance in endoscopy Faulty contacts will frequently occur in electrical circuits however carefully they be tested and a tiny spark may lead to a disastrous explosion

Local anæsthesia.—An hour before operation omnopon gr $\frac{1}{3}$ or morphine gr $\frac{1}{6}$ and Hyoscine gr $\frac{1}{150}$ are given hypodermically On arrival in the theatre the patient s upper gum margin is painted with a 10 per cent solution of cocaine hydrochloride. The cocaine solution is then painted over the right border of the tongue and fauces the tongue being held forwards by the operator with the aid of a gauze swab by which the tip of the tongue is grasped by the left thumb and forefinger A brush held on a right angled holder (the distal limb of the handle being 4 in long and the proximal about 7 in) is now used to cocainize in turn the pyriform recesses These applications will render the whole of the supraglottic portion of the larynx anæsthetic by their action on the superior laryngeal nerves which lie in relation to the mucosa at the lateral walls of the pyriform fossæ. This manipulation is performed on the recumbent patient the operator standing behind the head of the table Within a few minutes it is possible to introduce the laryngoscope and to spray the epiglottis and the interior

of the larynx by direct visual aid During the whole of these procedures the patient is repeatedly instructed to breathe quietly through his mouth and to refrain from clenching his fists as muscular exertion is always accompanied by closure of the larynx

General anæsthesia—Either an inhaled or an intravenous agent may be employed The laryngologist will usually prefer inhalation anæsthesia with chloroform or trichlorethylene which produce good relaxation and are free from the risk of explosion Since the advent of curare or tubarine many anæsthetists advocate the use of pentothal sodium with curare maintaining that the use of curare obviates the laryngeal spasm so often encountered with pentothal The author has not at the time of writing found laryngoscopy under pentothal curare-cocaine satisfactory Several cases have been encountered where patients with carcinoma of the larynx have died on the operating table of asphyxia due to spasm added to the obstruction caused by the growth At the present time the subject is controversial but the opinion of the author is that in obstructive lesions of the larynx intravenous anæsthesia is so dangerous that it is absolutely contra indicated Before concluding the discussion on anæsthesia it cannot be too forcibly stated that any form of general anæsthesia is highly dangerous in a patient who already has dyspnœa Preliminary tracheotomy is easily performed and is the greatest possible safeguard against sudden asphyxia.

Contra indications.—Jackson states that the only absolute contra indication to direct laryngoscopy is disease or dislocation of a cervical vertebra. The clinical observation that led Jackson to formulate this rule was drawn from a case of dyspnœa consequent upon retropharyngeal abscess originating in tuberculosis of a cervical vertebra.

Technique of direct laryngoscopy—The following rules are important and failures or difficulties in laryngoscopy are due to their non observance

(1) The patient s head must be held in the midline and whilst the neck is bent forwards the head must be bent backwards at the occipito-atlantoid joint This ensures that on introduction of the laryngoscope its long axis will assume the same direction as that of the pharynx and trachea.

(2) The tip of the epiglottis must be recognized and displaced forwards by the lip of the distal end of the laryngoscope It is easy to mistake the inter arytenoid crest for the upper margin of the epiglottis and forward traction on this produces an artificially slit like lumen of the hypo-pharynx which may be mistaken for the rima glottidis

(3) It is not justifiable to use great manual force in manipulations upon a delicate organ whose exposure should be easy If difficult the reason is to be found in a faulty position of the head or of the cervical spine Complete ossification of the stylo-hyoid ligaments may render direct laryngoscopy impossible

Indications.—Direct laryngoscopy is performed for —

(1) *Diagnosis* —It is generally agreed that in all cases of suspected carcinoma of the larynx a histological diagnosis is desirable. The appearances which lead to a suspicion of cancer are well known—ulceration or a papilliferous proliferation on one vocal cord especially of its middle third especially the classical snow white irregular warty mass being frequently observed in this disease. But it is the experience of all laryngologists that the same appearances may be produced by syphilis or tuberculosis as well as by cancer and that in any case both or even all three conditions may co-exist It is therefore necessary in all cases to carry out the following examinations X ray of the lungs sputum examination Wasserman reaction and if these tests be negative histological examination of a biopsy specimen Before embarking on direct laryngoscopy and biopsy any dental sepsis or suppuration in the nasal sinuses should be treated. Treatment of oral or nasal sepsis often leads to the resolution of laryngeal granulomata and in cases of doubt it is permissible to wait for a month and to observe the appearance of the lesion It is indicated later (p 1714) that the histological diagnosis may be equivocal In a recent case four histological examinations were made none revealing evidence of malignant disease but on clinical grounds a complete laryngectomy was performed on the advice of Mr L Colledge and the extirpated larynx revealed an extensive subglottic carcinoma which had spread across the midline beneath the anterior commissure of the larynx *

(2) *Removal of granulomata or benign tumours* of the larynx The spoon or cup-jawed forceps of Chevalier Jackson are most suitable for the removal of nodules from the edges of the cords For the treatment of papillomata diathermy fulguration is suitable using either a rigid insulated electrode or a flexible electrode whose distal end is held in laryngeal forceps and applied to the surface of the growth

(3) *The local treatment of laryngeal tuberculosis* is best carried out by direct laryngoscopy The ulcers can be treated by galvano-cautery or by diathermy coagulation. Professor Ormerod prefers cautery to diathermy in the larynx.

(4) *Laryngeal foreign bodies* are best removed by this method. In very rare cases a foreign body may be so impacted as to require the external operation of thyrotomy for its removal

TRACHEAL OPERATIONS

Tracheotomy or Tracheostomy

The word tracheotomy is often associated in the mind of the student with a mental picture of rapid slashes of the knife at the throat of a deeply cyanosed child It happens of course in rare instances that the operation has to be performed under very unfavourable conditions but in the vast majority of cases the conditions necessitating this step are progressive and the indications are evident early enough to permit

* McKeown, *Journ. Laryngol* 1962.

a deliberate operation The need for uncomfortable speed in other cases may be largely prevented beforehand by careful routine For instance no operation upon the respiratory tract should be undertaken unless a tracheotomy set or intubation set is ready at hand and the equipment of every laryngologist and anæsthetist should comprise the necessary instruments

Indication.—The indication for tracheotomy is obstructed respiration and in a large number of conditions the indication may arise somewhat suddenly

(1) *Diphtheria* offers the widest sphere of usefulness about 1 per cent of cases are likely to require operation (*see* Table on p 1706)

(2) *Acute laryngitis* with œdema as the result of sepsis trauma inhalation of irritating gases chemicals or steam in acute specific diseases other than diphtheria in the course of renal or cardiac disease or as the result of excessive indulgence in spirits or overdoses of drugs such as potassium iodide or in allergic subjects

(3) *Dyspnœa* arising during surgical operation or at other times from the inhalation of foreign bodies

(4) *Fracture of cricoid and thyroid cartilages or hyoid bone* with œdema and perhaps surgical emphysema may suddenly produce obstruction

The other conditions requiring tracheotomy for the most part give ample warning

(5) *As a preliminary to operation* likely to cause immediate or delayed respiratory obstruction for example removal of the upper jaw or diathermy of a growth at the base of the tongue or to facilitate endotracheal and endobronchial manœuvres

(6) In some cases of *cut throat or gunshot wound involving the air passages* where blood may enter the trachea

(7) *Compression of the trachea* from without by swellings in the neck or mediastina which are not removable by operation. Examples of these are swellings of the thyroid and thymus glands aneurysms and growths

(8) *Obstruction by tumours* of the larynx or trachea as papillomata and carcinomata of the larynx or by impacted foreign bodies (Fig 705)

(9) *Bilateral abductor paralysis* resulting from the various forms of toxic neuritis syphilis diphtheria tabes or following thyroidectomy (Fig 705 F)

(10) *Laryngeal spasm* may necessitate tracheotomy to save a failing heart or to aid artificial respiration during chloroform induction

(11) *Congenital laryngeal stridor congenital webs of the air-passages epilepsy* and *ankylosis of the crico-arytenoid joints* are rare conditions occasionally calling for tracheotomy

(12) *Tertiary syphilis* acquired or congenital may cause obstruction by the swelling accompanying perichondritis of the laryngeal cartilages and tracheotomy has occasionally been found necessary in tuberculous disease of the larynx.

The classical symptoms given as calling for tracheotomy namely recession of the chest working alæ nasi laryngeal excursion and weak pulse should not be allowed to develop Their presence leads



Fig 705 —Tumours, etc., of the larynx

A, The larynx in inspiration B, fibroma; C, tubercle; D, papillomata; E, extrinsic epithelioma F bilateral abductor paralysis

to inability to take nourishment further weakness and so to a vicious circle of deficient aeration more toxæmia and weaker heart It is found in the elderly that death often follows a successful tracheotomy prolonged anoxæmia having produced a myocardial weakness which does not recover after the airway has been re-established

Surgical anatomy.—There is a considerable difference between the conditions in the tracheotomy triangle in adults and in children.

In children the neck is relatively shorter and so the larynx appears higher. The trachea does not leave the surface so rapidly from above downwards as it does in adults, which makes it somewhat easier of access, but on the other hand the laryngeal cartilages and the trachea are softer and very difficult to distinguish if there is congestion of the cervical veins. The trachea is more mobile than in adults and so is easier to miss if the head be rotated ever so slightly from the mid position. In children again the jugular veins are relatively larger and the left innominate vein may be higher in the neck. The thyroid isthmus is relatively broader and higher up, while the thymus may in rare cases extend into the neck so as to lie in contact with the isthmus.

The trachea varies in diameter at different ages, being 4 mm. at 6 months, 7 mm. at 2 years, 10 mm. at 4 years, 12 mm. at 10 years and 29 mm. at 20 years. Its length is 4½ in. at maturity and there are only 2½ in. available above the suprasternal notch for operative purposes. This can be slightly increased by extending the head, which also lessens the distance from the surface.

Even in an obese adult the hyoid bone and the thyroid cartilage can usually be palpated, but it is not always easy in children to define the lower border of the cricoid cartilage, the upper limit of the trachea.

The *pretracheal fascia* is firmly attached to the cricoid cartilage above and passes down in front of the trachea, splitting to enclose the thyroid isthmus as it overlies the 2nd, 3rd and 4th cartilaginous rings. Then going deeper it passes behind the sternum and blends with the fibrous pericardium. Hence the grave risk attending local infection, which, if deep to this fascia, tends to track down to the mediastinum.

Veins are important. The left innominate may cross the trachea obliquely as much as ½ in. above the suprasternal notch and is liable to injury. The inferior thyroid veins run down vertically from the lower border of the isthmus. Provided the incision is placed mesially, the anterior jugular veins running downwards in the superficial fascia should not be injured.

Arteries do not usually give trouble. The thyroid isthmus is partially supplied by anastomotic branches of the superior thyroid artery; there is usually a branch of supply from the inferior thyroid artery. Rarely the thyroidea ima branch of the innominate passes upward in front of the trachea.

Instruments.—Small scalpel, two pairs of toothed dissecting forceps, four fine pointed pressure-forceps, two double-hook retractors, one sharp and one blunt hook, aneurysm needle, scissors, needles, tracheotomy dilator, tubes and tapes, and an intratracheal catheter should be available. The tubes should be provided with a movable shield which lies flush with the neck. For general use the tubes of Jackson and Durham are most serviceable, and an introducer is essential.

Preliminary considerations.—Where time permits, tracheotomy should be performed in an operating theatre with every appurtenance

likely to facilitate the procedure A suction apparatus is exceedingly valuable after the trachea has been opened and should be available in every operating theatre.

For a child a large towel should securely envelop the body arms and legs so that one assistant suffices to control the movements of parts other than the head A pillow should be placed under the shoulders so that the head can be hyperextended and supported exactly *in the midline by a nurse*

An *anæsthetic* is not essential But in children provided the pulse be strong general anæsthesia is desirable as breathing is often less laboured after induction is complete and consequently movement and bleeding should diminish In adults local anæsthesia is satisfactory St Clair Thomson in non-diphtheritic cases injected a few minims of a 2½ per-cent solution of cocaine into the trachea three minutes before opening it thus avoiding the burst of coughing which otherwise usually follows.

In operating on children the proper use of the sharp hook is most important As soon as the incision has been made it should be thrust into or beneath the lower border of the cricoid or the trachea strictly in the middle line and securely held by an assistant It must not be removed until the tube is safely in position Its use is (1) to mark the midline (2) to steady the trachea and (3) to draw the trachea nearer to the surface.

Tracheotomy is facilitated by the preliminary passage of an intra tracheal catheter and surgeons should familiarize themselves with this procedure which is usually reserved for the administration of anæsthetics When performing tracheotomy on a patient who is suffering from obstructive asphyxia the surgeon should ignore the profuse bleeding which occurs After opening the trachea the venous engorgement is greatly reduced and the surgeon can methodically proceed to deal with all bleeding vessels

Operation. (1) **Crico-tracheotomy** (section through the cricoid cartilage) —This though sometimes performed in emergency should never be planned and if done should be changed into a lower tracheotomy at the first opportunity

(2) **Infra-cricoid tracheotomy** —Davis* introduced a simple operation which may take the place of laryngotomy for the relief of laryngeal obstruction of great urgency The nail of the left index finger is placed at the lower border of the cricoid cartilage and a scalpel with the blade turned transversely is inserted horizontally into the trachea above the first ring and twisted a little so as to permit air entry A Butlin s laryngotomy tube is now inserted in place of the knife

(3) **High tracheotomy** (section above the isthmus) —This is the operation of choice in children with acute laryngeal obstruction and in adults may occasionally be necessary in obese short necked

* *Proc* [illegible]

individuals or where a growth embraces the lower part of the cervical trachea. In cases of extreme urgency it is undoubtedly the easiest tracheotomy but it is open though in a lesser degree to the criticisms applicable to crico-tracheotomy and wherever possible a low tracheotomy should be substituted if the obstruction is to persist

The surgeon stands at the right side of the head The landmark of the pomum Adami having been recognized by palpation the cricoid cartilage is sought for and gripped between the left thumb and forefinger and from its lower border a median vertical incision 1¼ in long is made downwards towards the sternum. In young children in whom the cricoid is difficult to locate the incision should be made in such a position that its lower end reaches almost to the sternum thus avoiding the mistake made by beginners of placing the cut too high over the larynx. The skin and subcutaneous fat are divided between the anterior jugular veins and the bleeding is controlled by forceps The sterno-hyoid muscles are exposed and the interval between them is opened up by dividing the anterior layer of deep cervical fascia. These muscles and the sterno-thyroids beneath them are separated for at least an inch and may be retracted if the muscles alone are included and the retraction is equal on both sides Keeping still in the middle line, and steadying the trachea the surgeon now divides the fascia covering the larynx and exposes the front of the cricoid and below it the vascular isthmus of the thyroid gland The landmark required at this stage is the cricoid and along it a small transverse cut should be made through the pretracheal fascia under which the handle of the scalpel can be introduced the isthmus with its fascial covering being stripped downwards towards the lower part of the wound where it is held by a blunt hook The surgeon can now see or feel with his finger the upper rings of the trachea and the retractors should be re-introduced so that it is thoroughly exposed

It is advisable to secure all bleeding points and to ligature the vessels at this stage if the patient s condition is satisfactory While the trachea is being opened the movements of the larynx should be controlled by grasping the cricoid with the finger and thumb of the left hand The scalpel should be held with the edge upwards and stabbed gently into the trachea to ensure division of the mucous membrane with the outer coats of the tube The incision must be precisely in the middle line and must be made with restraint for fear of puncturing the œsophagus In adults the tracheal rings may be ossified and section with a scalpel impossible If there is urgency the knife should be introduced transversely between the rings and the rings separated Otherwise small bone-shears can be used. The opening should be circular dividing not more than two rings so that as far as possible it is completely blocked by the cannula which is introduced. This in a large measure prevents the escape of septic material into the mediastinum. If the dyspnœa is severe there is a sudden rush of air out of the lungs as the tracheal wall is penetrated. The dilator is introduced and the anæsthetic abandoned Temporary

apnœa often follows the first inspiration but the colour improves and after an interval coughing commences mucus pus or membrane is expelled often in large amount and deeper inspiration and expansion of the chest follow The help afforded by the suction pump at this stage is invaluable If necessary oxygen should be given to assist the respiration.

As soon as breathing is regular a cannula of suitable size should be quickly inserted This rarely presents any difficulties if the opening is well dilated and an introducer employed. It is easier if the divided ends of the cartilages are excised *so that a circular opening is produced* as recommended by Trotter This method has the great advantage that the tube can be easily changed The tube must sit well without tilting and must be fixed by tying the tapes firmly round the neck. It is important that the fixing screw in the shield be inserted at the proper side It is impossible to fix the collar unless the screw be inserted from the smooth into the threaded side. Wrong assembly has led to looseness in the shield with consequent expulsion of the tube on coughing and death from asphyxia has followed a successful tracheotomy from this cause Having been cleared of blood, the wound should be moistened with sulphonamide solution or if there is time this should be applied before opening up the trachea. Application of penicillin and sulphonamide powder with an insufflator is a valuable method of reducing infection in the wound A thin layer of glycerine-gauze is cut half across and slipped under the shield so as to embrace the tube The inner tube is changed frequently

(4) **Median tracheotomy** (section through the isthmus of the thyroid gland) —The incision through the skin and superficial fascia should be rather longer than in the high operation The infrahyoid muscles are separated as before. The isthmus is exposed and in a child can be cut through boldly in the middle line bleeding points being seized before the trachea is opened. In adults when there is no urgency it is better to ligature the isthmus in two places either by passing a threaded aneurysm needle under it or by clamping it with forceps leaving a space of ½ in in which the isthmus can be divided. The trachea is thus exposed and can be opened as before Trotter has pointed out that this type of operation has the advantage that should the tube be removed there is no difficulty in re-introducing it. In both high and low tracheotomy the isthmus is pulled out of its normal position and tends to slip back on removal of the tube partly covering the tracheal incision. Median tracheotomy is the operation of choice in most cases

(5) **Low tracheotomy** (section below the isthmus) —A long incision is needed and should extend down to the suprasternal notch. (Fig 706) In dividing the fasciæ which are thick and loose near the sternum there must be no tailing of the skin wound. The isthmus must be exposed by separating the infrahyoid muscles and its lower border determined and drawn upwards by a blunt retractor

It will be noticed that the trachea is more deeply placed than in high tracheotomy and it is important to remember that it is more difficult to expose owing to the numerous veins that lie in front of it Deep cutting is therefore dangerous The trachea must be exposed by deliberate dissection Bleeding points must be seized and the trachea thoroughly exposed before it is opened A long tube will be needed for preference with an adjustable shield as in Durham s instrument

Low tracheotomy is the operation of choice if the obstruction be caused by laryngeal epithelioma and the opening into the trachea must

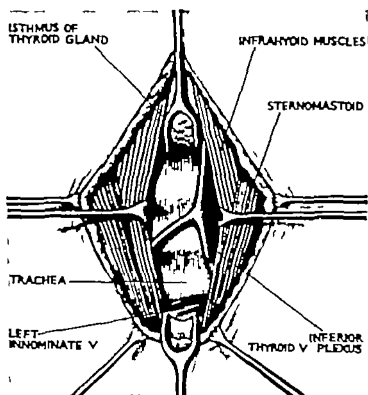


Fig. 706 —Exposure of the trachea for low tracheotomy

be made after deciding whether or not a subsequent laryngectomy is to be performed A low tracheotomy will lead to difficulty in uniting the edges of the trachea and the skin when the larynx has been excised Low tracheotomy may be a very difficult operation and the clear exposure of the trachea indicated in Fig 706 is never attained in operative conditions

Tracheotomy becomes difficult if any of the cardinal rules are transgressed. To reiterate The head must not be allowed to rotate at all and the incision must be truly mesial Extension of the head is helpful provided that congestion of the cervical veins is not thereby rendered more severe. The pomum Adami can always be found and if the trachea is missed this prominence can be exposed and the cricoid and trachea followed down therefrom. The greatest difficulty is likely to be due to hæmorrhage from veins This

can be avoided and struggling diminished by a timely decision to operate indeed this is the solution of nearly all the usual difficulties both during and after the operation Blood must not be allowed to enter the trachea If suction is available it is helpful in preventing this if not the head may have to be lowered after the trachea has been opened and dilators introduced Venous *bleeding will stop as soon as respiration becomes free It is often found* that extension of the neck greatly increases the dyspnœa. As much as possible of the dissection should be done with the head and neck level extension being applied after identification and division of the white line of fascia between the opposite pre-tracheal muscle-groups.

Failure to breathe after an opening has been made in the trachea is *due to obstruction or to collapse In these circumstances* the trachea should be opened widely and a pair of forceps or a sucker passed down to the bifurcation to dislodge any obstruction and to promote coughing It is useless to employ artificial respiration unless the obstruction has been removed. Collapse should be treated by compressing the limbs with Esmarch's bandages by lowering the head and by *warmth and artificial respiration* should be continued In cases of great emergency a rapid operation without anæsthetic is forced upon the surgeon The larynx is gripped by the left thumb and finger and held firmly while a long incision is made downwards from the cricoid and deepened with total disregard of bleeding until the trachea is reached The trachea is stabbed in the midline and the blade rotated through a right angle This will permit one breath after which the dilators are guided into the opening with the help of the left forefinger The patient is then drawn over the end of the table so that the head hangs downwards The bleeding soon ceases

After-treatment.—A warm airy room with steam inhalations is advisable In septic cases inhalations of benzoin or menthol are indicated. Feeding is difficult and may have to be done through a *nasal tube Dilators should be kept handy and an experienced* person must be at the bedside as long as there is any membrane bloodclot or discharge in any quantity A return of dyspnœa points to the need for removing and cleansing the inner tube. Especial care must be taken to see that the tube is not merely outwardly cleansed but that the lumen is cleared of adherent mucus or mucopus. Should this cleansing process fail to relieve dyspnœa, the trouble is probably due to the tube having slipped out Its replacement is facilitated by a good light and the use of an introducer The cannula should be removed as soon as the secretions become small in amount and serous rather than purulent In diphtheria the period varies *from five to* fifteen days after which the case must be regarded as one of retained tube It is a good plan to replace the metal tube by a rubber one three or four days after the operation and to dispense with the latter as soon as possible If the child is unable to breathe with the tube

occluded stenosis of the larynx should be suspected and a laryngoscopic examination made Sometimes the difficulty is merely functional and can be overcome by re-education After removal of the tube assuming that the original obstructive condition has disappeared the wound heals readily and should be closed in a few days

Complications.—*Hæmorrhage* reactionary or secondary is likely to lead to urgent dyspnœa from inhalation of clot The former is unlikely in patients operated upon by those accustomed to deal with such cases Secondary hæmorrhage is usually fatal but luckily rare Kocher could only find 87 cases in the literature and in 56 of these the bleeding was from the innominate artery This is an argument against low tracheotomy but since the general use of antitoxin and the omission of sutures below the tube (Jackson) wound infection has become uncommon and the incidence of secondary hæmorrhage much less Sepsis in the wound has been greatly diminished since the advent of sulphonamides and penicillin

Ulceration —Ulceration of the mucosa may be due to pressure of the tube owing to a too high tracheotomy or to want of care in seeing that the tube sits nicely It is a serious complication Besides leading to retained tube there is grave risk of stenosis if it is allowed to persist for any time A lower tracheotomy may be necessary to remove the irritation of the tube from the ulcer but in milder cases it suffices to replace the metal by a rubber tube and to treat the ulcerated area by caustics.

Paralysis —In diphtheria a retained tube may be due to abductor paralysis of the vocal cords this may sometimes persist Fatal cardiac paralysis occurs but rarely although paralysis of the soft palate is often seen. Sensory paralyses are less easily recognized and are of less urgent importance unless the cough reflex is impaired

Bronchitis and broncho-pneumonia are common and seriously prejudice the prognosis

Among the less important complications emphysema of the tissues about the wound is common but unless it extends to the mediastinum it is not likely to do harm It is due to excessive use of skin sutures. The skin should never be closely approximated around the tube After removal of a tracheotomy tube healing is prompt and scarring trivial

Prognosis.—It is difficult by giving percentages to form an accurate picture of the risks of this operation Of the deaths occurring after tracheotomy there are very few that would not have occurred had the operation not been performed The deaths rightly attributable to the operation are those due to hæmorrhage and sepsis. More often death is due to a tardy decision on the part of the medical attendant to carry out the operation This is especially so in young children with diphtheria the patient s heart being so rapidly exhausted and in the aged who do not recover from prolonged anoxæmia.

TABLE SHOWING THE INCIDENCE AND MORTALITY OF TRACHEOT
COMPARED WITH INTUBATION PERFORMED UPON CASES OF DIPHTH
THE INFECTIOUS DISEASES HOSPITALS OF THE LONDON COUNTY (
DURING THE YEARS 1932–35 *

Total cases of Diphtheria	Tracheotomies	Deaths	Intubations	D
29 387	318	98	10	

Figures quoted by W Napier† of Glasgow show a mortality 25 per cent in cases treated by tracheotomy figures for int varying from 28 to 44 per cent.

It must be realized that death is usually due to the results disease rather than to an operation which in a healthy person almost be considered trifling and which is not attended by not shock The mortality in other infective diseases such as ery smallpox typhoid whooping-cough and influenza treated by t tomy is very high (74 8 per cent) owing to the severity of the to The mortality from this operation before the days of dip antitoxin used to be over 70 per cent

The age of the patient is important in children under one age only one in three recovers. The death rate decreases gra between the ages of one and six years.

INTUBATION

Until shortly before the last war intubation of the referred merely to the intubation employed in diphtheria. Bu are two other distinct types of intubation now in use which detailed description firstly the form which has been evolve anæsthetic practice and secondly the prolonged intubation de to overcome stenosis caused by scar tissue

1 **Intubation in diphtheria.**—This has a definite place milder cases where antitoxin has been given early.‡ In most hospitals the recognition of the safety of tracheotomy when out early enough has relegated intubation to a less important p

Instruments.—A gag for opening the mouth a set of short tubes of vulcanite or light metal with a gauge showing the si different ages an instrument for intubation and extubation equipment for tracheotomy

Two assistants are necessary one to hold the patient the ot control the head and the gag

Operation —Anæsthesia is not required even for children *as* ments can be controlled by wrapping the patient in a large to

* Figures obtained by courtesy of the Medical Officer of Health for the L.C.C.
† *Lancet*, Sept 18 1937 ccxxxiii, 691
‡ See paper by A L K Rankin, Direct Laryngoscopy and Aspiration in Laryngeal Diphtheria. *Trans.* *Soc. Lond* lxiv p 10 1944–46.

blanket with the arms extended by the sides One assistant holds the child either sitting up or lying on the back with the head extended over the table. A tube is chosen in accordance with the patient s age threaded and mounted upon a Thorner s introducer and the mouth gagged widely open The head being extended the surgeon passes the left index finger over the back of the tongue and behind the epiglottis The landmark required is the cricoid cartilage As soon as this is felt the finger is drawn forward so as to hook up the epiglottis

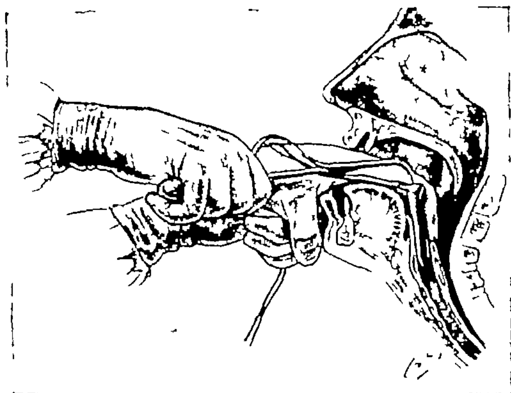


Fig 707 —Intubation.

and the introducer and the tube are rapidly passed over it The handle of the introducer must be raised as high as possible so as to throw the point of the tube against the back of the epiglottis The instrument is boldly lowered thus passing the tube through the larynx until its collar rests firmly upon the ventricular bands It should be held in place with the left index finger while the introducer is removed The operation should take from three to five seconds and should be performed without force (Fig 707)

Failure to find the opening is generally due to not keeping the instrument in the middle line or to the use of too large a tube Too small a tube is at once coughed out The tube though properly passed may push membrane in front of it or may be blocked by membrane in which case tracheotomy is indicated The tube may pass into the œsophagus and may increase the dyspnœa by pressing on the back of the larynx or the tube with its thread may slip through

the gullet into the stomach This is not a serious accident as the tube will be passed per rectum or more rarely vomited Frequent expulsion of the tube by coughing or urgent dyspnœa, is also an indication for tracheotomy

After treatment.—A tracheotomy set and intubation instruments must be kept by the bed and someone competent to do intubation or tracheotomy must be at hand in case the tube is coughed out and the dyspnœa recurs. There is usually an interval of at least twenty minutes before dyspnœa becomes urgent Blocked tubes are more dangerous but are generally expelled unless the child is weak. If a thread is left the nurse can extract the tube but care must be taken that the child does not pull it out Swallowing may be difficult and liquids passing through the tube may cause coughing Tracheotomy should be performed if the child urgently needs nourishment

Changing the tube —The tube should be left *in situ* for forty-eight hours and then changed daily aiming always at removal as early as possible, but this will probably not be before the fifth day

Complications.—Intubation in diphtheria is not invariably free from dangers immediate and remote apart altogether from failure to relieve the obstruction There may be injury to the larynx with resulting hæmorrhage emphysema or abscess and even false passages are not uncommon The pressure of the tube may lead to ulceration associated with increase of the obstruction and to œdema or granulations or more remotely to cicatricial stenosis Jacobson describes a type of stenosis following intubation other than that caused by trauma, the obstruction being due to paralysis of the cords. This may help to explain the frequency of retained tube after intubation

It is claimed that intubation has the following notable advantages over tracheotomy in diphtheria The knife is not used and there is no skin wound to deal with afterwards and the absence of cutting and of the need for an anæsthetic makes it easy to obtain the consent of relatives. Introduction of the tube requires very little time and the tube is more easily worn than in tracheotomy The upper air passages are not starved of the air necessary for their proper ventilation, and the results are better in children under 5 years (the group in which there is such a notable mortality with tracheotomy) On the other hand the dexterity necessary for intubation with the speed required by the interference with respiration is only obtainable under the conditions met with at fever hospitals and even in the most favourable surroundings failure is not infrequent

Goodall finds that 28 per cent. of the tubes are coughed up and 12 per cent blocked. The tube often interferes with deglutition while its lumen though just adequate for breathing does not permit free expectoration Its greatest condemnation is that the outfit must comprise a tracheotomy set—for one third of all cases need secondary tracheotomy Further this fact evidently calls for the constant presence of the medical man even after a successful introduction of

the tube A comparison of the results at hospitals using tracheoto with those where intubation was preferred shows that mortality noticeably less with tracheotomy

2 **Intubation for non-diphtheritic obstructions.**—Whereas it to be taken for granted that the natural intolerance of the lar made prolonged intubation impracticable except in fever hospita growing familiarity with endotracheal work has shown that a g elastic catheter may be tolerated in the larynx for a surprisingly time without harm (in one case at St Bartholomew s Hospital

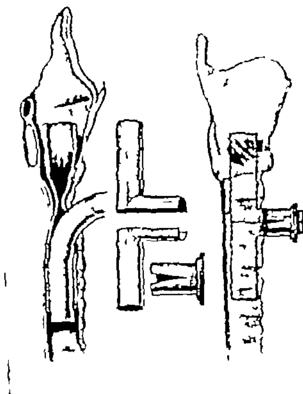


Fig. 708 —Stenosis treated by intubation.

The left-hand figure shows Harmer's method of obtaining an elastic dilating pressure within th stricture, while ensuring patent airway A metal cannula passes into the trachea through fenestra in the anterior aspect of a rubber tube which occupies the lumen of the stricture Th remaining figures illustrate the use of a three-piece metal tube for intubation

fourteen days) At the Cancer Hospital it is the practice to l catheters in the trachea of patients suffering from *laryngeal* car mata for as long as forty-eight hours the throat being *sprayed* hourly with cocaine

It is possible* to intubate the trachea via the nose without assistance of vision and this useful manœuvre may under ce conditions obviate tracheotomy

Two forms of tube are suitable either a gum-elastic catheter piece of rubber tubing with the leading end cut obliquely *to a p* both require thorough lubrication with petroleum jelly Succe

* I W Magill, *Proc Roy Soc of Med.*, Dec., 1928, xxii, 183

passing the catheter depends on the shape of the curve rather than the skill of the operator By practice upon the cadaver this is found to be somewhat like a capital C the curve being maintained by a stylet I have used this manœuvre successfully as an emergency without previous training and can emphasize its simplicity It certainly requires much less skill than a tracheotomy and can if urgency dictates be attempted by an assistant while the surgeon begins the tracheotomy to prevent possible loss of time It can also be done under *local* anæsthesia This has been of particular advantage in the treatment of laryngeal growths by X rays the tube is worn during the swelling of the growth sometimes met with during the earlier days of treatment and is removed when the shrinkage has restored a safe airway

Intubation of the larynx *via* the mouth by gum-elastic catheter under the guidance of vision through a laryngeal spatula has also been useful in my experience as a preliminary to tracheotomy in an urgent case of tracheal obstruction due to a large vascular thyroid growth which rendered successful tracheotomy problematical. Artificial respiration was done through the airway thus supplied until the patient was somewhat restored after which tracheotomy was performed unhurriedly and without the bleeding usually associated with respiratory obstruction. A suitably shaped catheter and a laryngeal spatula should be available in operating theatres and in the laryngologist s bag as well as a tracheotomy set

Stenosis of Larynx or Trachea

Harmer has tried with considerable success a method of treating stenosis of the larynx which depends on gradual dilatation of the stricture by elastic pressure. (Fig 708) A strong silk thread is passed via the mouth through the stricture and is then brought out through the tracheotomy wound With the help of this thread a large rubber tube is introduced into the larynx through the tracheotomy and is manœuvred into position in the grip of the stricture by alternately pulling from above and gently pushing from below It may not be possible to get it right through the stricture at the first attempt. A fenestra is made on the anterior aspect of the rubber tube opposite the tracheotomy wound and through this an ordinary tracheotomy tube is introduced so that its lower end projects beyond the rubber tube into the trachea. The length of that part of the rubber tube above the fenestra determines the degree to which it presses into the stricture and this length is gradually increased from week to week. Ultimately it is pulled up so that it lies wholly in the stricture and can after some weeks or months be replaced by a slightly larger size and so on until patency is restored.

The advantages of this method are that the pressure which is applied being elastic is not sufficient to cause anæmia of the mucosa and so ulceration is not produced

Bedford Russell has successfully varied this method of dilatation of the larynx with an ordinary rubber tube.* A loop of silk is worn in the larynx, the ends of which project from the mouth and from the tracheotomy. The patient himself carries out the dilatation, pulling through the stricture firstly a very fine calibre rubber catheter, and then gradually increasing sizes of catheter until the size of a stomach tube has been achieved. Each size has to be worn for about a month, and the dilatation is found to be permanent after about eighteen months.

Tracheo-fissure

Tracheo-fissure is most often used for the relief of stenosis of the trachea resulting from inflammatory conditions such as diphtheria, syphilis, foreign bodies, gunshot wound, cut throat and inhalation of irritants. It has been not infrequently employed, chiefly in America, to obtain access to endotracheal tumours. Thiesen† collected 186 cases, of which 89 were innocent growths such as papilloma, fibroma and masses of misplaced thyroid tissue.

The operation is really an extensive tracheotomy. The incision should be boldly extended until an adequate view of the endotracheal condition is obtained. It is sometimes possible to cure cicatricial stenosis by inserting a small cannula at the operation and subsequently dilating the stricture with tubes gradually increasing in size.

If dilatation fails, it may be possible to excise the scar tissue and to obtain gradual epithelization of the lumen around the cannula, normal function being ultimately restored. For tumours an insufflation catheter is passed into the trachea below the growth and tamponned off before the tumour is excised. Bleeding is controlled by electric cautery after free removal of the growth, and a tracheotomy cannula is inserted and left *in situ* for several days. Von Bruns‡ has obtained cures in four cases of intratracheal thyroid tumours removed by this method. Stenosis of the trachea and of the larynx have been successfully treated by the method devised by Professor Schmiegelow described later (p. 1720).

Resection of Trachea

This is a rare operation, the only indications being malignant tumours limited to the tracheal wall and stenosis, e.g. after some cases of cut throat.§

The operation is begun as a tracheotomy. The trachea is divided transversely above and below the lesion and an endotracheal catheter with return airway immediately passed down to the bifurcation, tampons being inserted round the tubes to prevent the ingress of blood.

The operator will try carefully to avoid injury to the cervical vessels and to the recurrent laryngeal nerves during the removal of the

* *Proc. Roy. Soc. of Med.* (Sect. Laryngol.), Mar. 1928, xxi, 25.—See also *Proc. Laryng. Soc. of London*, 1895, 82, 83.
† *Trans. Amer. Laryngol. Assoc.*, 1906, xxviii, 284.
‡ Bergmann's "System of Practical Surgery," xi, 49.
§ Grey Turner, *Brit. Med. Journ.*, June 8, 1909, i, 1335.

affected portion of the trachea. A growth may have transgressed the tracheal wall and be adherent to those structures and catastrophic bleeding may occur during this stage

If less than 4 cm of the trachea has been removed, it is possible to bring the cut ends together with numerous catgut sutures * or one or two silk worm stitches left with long ends to facilitate removal Care is necessary to prevent extension of the head for some days afterwards Free drainage is required to guard against the escape of septic matter into the tissue planes of the neck. In certain rare cases it may suffice to remove a lateral portion of the trachea—a window The defect can be repaired by muscle and fascia.

Results.—Von Bruns had favourable results in seven cases the operation in a case of carcinoma involved removal of the posterior wall with six rings of the trachea.

Harmer obtained a satisfactory result in a case of thyroid malignancy with a small mass of growth in the trachea. The case had been first seen by a medical colleague for hæmoptysis Local anæsthesia was employed, and severe hæmorrhage overcome with the help of a motor suction apparatus. The cut ends of the trachea were brought together and the patient lived in good health for about a year

Rob and Bateman describe reconstruction of the trachea and cervical œsophagus after extensive resections.†

EXTERNAL OPERATIONS ON THE LARYNX

INFRATHYROID LARYNGOTOMY

Indications.—This operation is suitable (1) *in emergencies* by reason of the speed with which it is performed and (2) *as a preliminary* to set operations because of the negligible amount of trauma inflicted It is employed in cases of sudden laryngeal obstruction by food or inhaled foreign bodies or by œdema of the larynx due to trauma or sepsis. It may in rare cases be necessary to prevent cardiac failure in crises of obstruction accompanying spasm of the glottis or bilateral abductor paralysis

Problems of anæsthesia in large operations upon the tongue floor of the mouth and jaws where bleeding is usually severe are solved by giving intratracheal anæsthesia Patency of the airways is thus ensured and the anæsthetist is removed from the field of operation. A large tethered marine sponge is passed into the pharynx to prevent anything reaching the larynx from above

The operation is only suitable for adults as the crico-thyroid space in children will not take a tube adequate for respiration Nor should the tube be left in for more than forty-eight hours for though it lies in the subglottic space and the vocal cords are free from risk of injury if it is introduced carefully yet inflammation is likely and there is risk of ulceration with its attendant troubles if retention is prolonged.

* Harmer Keen's Surgery 1908, p. 510. † *Brit. J Surg* 1949 37 202.

Instruments.—Sharp-pointed knife sharp-pointed dilator laryngotomy tube and tapes with pointed introducer

Operation —The crico-thyroid space having been identified by palpation a small fold of skin over it is pinched up by the assistant between the forefinger and thumb of each hand. The fold is transfixed transversely with the knife and the blade brought out through the skin. By this method there is less likelihood of injuring the veins A sharp-pointed dilator is then forced deeply through the crico-thyroid membrane and opened widely (Fig 709) It is withdrawn and at

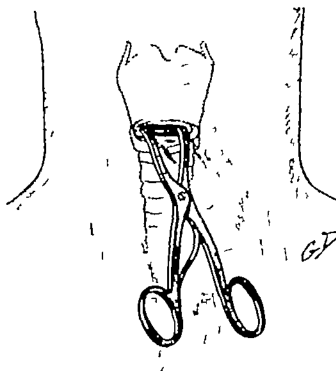


Fig. 709 —Laryngotomy dilators tearing the crico-thyroid membrane.

once replaced by the tube on its introducer After removal of this instrument the operation is completed by tying the tapes round the neck.

No bleeding is experienced by this method since the only vessel met with the small crico-thyroid artery is pushed aside by the dilators A burst of air follows the insertion of the dilators which should have been pushed far enough in to penetrate the mucous membrane A period of apnœa often follows and can be disregarded.

Of course the opening may be made by incising the membrane transversely with a scalpel the outer part of the bivalve tube may then be introduced without using any special instrument

Complications.—If performed as described this operation is rarely complicated *Hæmorrhage* is uncommon but may originate from a

vein superficial or deep or from the crico-thyroid artery This artery is usually small but Durham stated that serious or even fatal hæmorrhage has occurred from it If necessary the wound must be freely opened the muscles drawn apart and the bleeding vessels secured.

Emphysema may occur if the wound is sutured or a dressing tightly applied. *Ulceration* and more remotely *stenosis* should not occur if the tube is not retained for more than two days

Carcinoma of Larynx

The remaining operative intrusions upon the larynx are chiefly used in the treatment of malignant disease which in an overwhelming majority of cases takes the form of epithelioma.

Classification. (*a*) Clinical —Krishaber in 1879 classified laryngeal carcinomata into

(i) *Intrinsic* arising from within the laryngeal box i e. vocal cords (80 per cent) ventricles and ventricular bands (10 per cent) and the region of the anterior commissure (10 per cent)* *These growths tend to remain unilateral.* This group includes subglottic carcinoma, the growth originating in the epithelium covering the conus elasticus below the level of the rima glottidis In their early stages such growths are not visible by laryngoscopy nor will they produce symptoms.

(ii) *Extrinsic* arising from the epiglottis arytenoids ary epiglottic folds pyriform fossæ and pharyngeal aspect of the cricoid (*including intrinsic growths which have transgressed their boundaries*)

(*b*) Histological.—Broders has further classified these growths histologically into four groups In Group I there is well marked differentiation of the cells which closely resemble normal epithelium and a tendency to form keratin or cell nests Invasion and metastasis are slow and conservative surgery gives very good results. Fortunately the majority of intrinsic growths approximate to this type In Group IV at the other end of the scale the cells are anaplastic and show no tendency to form keratin or cell nests they invade the stroma diffusely show active *mitosis and tend to recur early* This type of growth may respond readily to irradiation.

Biopsy —In the past many surgeons have advised against biopsy in the belief that it might cause dissemination but Thomson and Negus† urge biopsy At St. Bartholomew s Hospital, where it has for some 50 years been the custom to perform biopsy on all laryngeal growths there has been no evidence suggesting a resultant scattering of cancer-cells In the majority of cases the biopsy was preceded and followed by a dose of X rays by way of precaution but of late years this has been omitted without ill results. Biopsy then is advisable

* Proportions are taken from Ombrédanne Traitement du Cancer Endolaryngé. 1930
† Diseases of the Nose and Throat, Cassell, 6th ed. 1955.

and it is to be hoped that the histological guidance so obtained will lead to a satisfactory selection of cases for the various forms of treatment. It is however not an uncommon experience that an ambiguous report is given by the pathologist. The criteria of malignancy are (*a*) embryonic character of the cells (*b*) cell nest formation (*c*) prickle cells (*d*) infiltration (*e*) invasion. It is rarely that a sufficiently

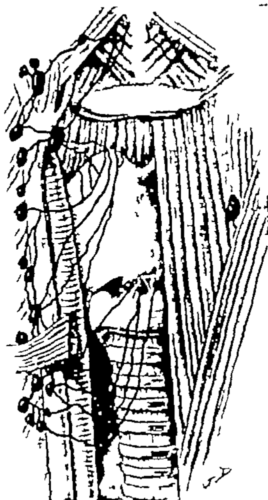


Fig 710 —Laryngeal lymphatics.
The drainage from the vocal cords leaves the larynx through the crico-thyroid space.
(*After Poirier and Cunéo.*)

extensive volume of tissue can be removed for an examination of all these factors to be made. In doubtful cases it is wise to keep the patient under close observation for a period of weeks or months if unnecessary radical surgery is to be avoided.

Intrinsic lymphatics.—Apart from histological considerations the difference between metastasis from intrinsic and extrinsic growths is largely explained by the differences in the direction and extent of the lymphatic drainage. The cords are not well served in the matter of

drainage the lymphatic vessels are scanty and the spread throu[gh] them is very slow being limited for considerable periods to one or t[wo] glands over the crico-thyroid membrane where they can be felt [as] small shot like bodies (*Fig* 710)

Very different is the drainage from the supraglottic region. T[he] lymphatic vessels here are plentiful and the spread is immediate [to] the deep cervical chain especially the digastric gland and the gland [at] the carotid bifurcation

Treatment for intrinsic growths.—The choice of treatment [lies] between surgery with or without diathermy on the one hand a[nd] irradiation either by interstitial radium teleradium or X rays on [the] other The majority of writers are strongly in favour of the former *

Surgical—The choice of operation depends on the stage which [the] growth has reached and as a rule three phases are recognized T[he] first phase of an intrinsic growth is easily definable the growth [is] limited roughly to the middle third of one cord and the cord is fre[ely] mobile In these cases it is possible to obtain a 5-year cure in o[ver] 80 per cent. of cases by laryngo-fissure † The operative mortality [is] almost negligible Chevalier Jackson‡ performed 120 consecut[ive] laryngo-fissures with no post-operative deaths

Phonation is usually surprisingly good the scar tissue on t[he] affected side heaps itself up so as to look remarkably like a vocal co[rd] when viewed by indirect laryngoscopy and the intact cord pl[ays] against this ridge so as to produce a rather thin but effective voi[ce] which can be greatly developed by education.

The reason for vocal inefficiency is that the fibrous band is placed a[t a] different level from the normal vocal fold—a fact that is not obvious [on] monocular laryngoscopic examination. Hence the importance [of] vocal re-education One patient after resection of a vocal cord h[as] continued his vocation as a night telephone operator for over six yea[rs]

1 LARYNGO-FISSURE

Indications.§—

1 Neoplasms of the larynx
2. Impacted foreign bodies in the larynx
3 Injuries of the larynx
4 Laryngocele
5 Stenosis of the larynx and certain operations for relief [of] abductor palsy
6 Acute laryngeal perichondritis
7 Laryngeal tubercle
8 Scleroma of larynx

* E. N Broyles, *Arch Otolaryng* 1936, xxiv 473.
† G. B. New and F A Figi, *Surg Gyn. Obst* 1936, lxii, 420.
‡ *South Surg* 1932, i, 222, and *Surg Gyn. Obst.*, 1934, lviii, 437
§ St. Clair Thomson and Negus, "Diseases of the Nose and Throat" Cassell 4th ed. 1937.

Preliminary considerations.—The complications to be feared are first infections of the lower respiratory tract and secondly descending infection behind the pretracheal fascia with its risk of mediastinitis Dental sepsis and sinus infection must be eliminated

It is wise to precede the main part of the operation by tracheotomy and to carry on the anæsthesia through the tube great care being taken to prevent blood from the operation area entering the lung This end is furthered by having the trachea tilted either by extending the head downwards over a sand bag under the neck or by tilting the table.

Tracheotomy ensures the maintenance of a clear airway with elimination of straining congestion and bleeding There is a growing tendency among French surgeons to dispense with tracheotomy in this operation. In England it is customary to employ local anæsthesia until a median tracheotomy has been performed The thyroid cartilage and crico-thyroid membrane are clearly defined before opening the trachea. Two c c. of 10 per cent cocaine solution containing 1 minim of $\frac{1}{1000}$ adrenaline are injected into the trachea a few minutes before incision of the tracheal ring

Instruments.—Tracheotomy set thyroid-cartilage shears two large retractors long curved scissors periosteal elevator aneurysm needle.

Operation for intrinsic growth. **Tracheotomy**—A median vertical incision is made from the hyoid bone to the supra-sternal notch and its lower half is deepened to expose the thyroid isthmus and the trachea. A median tracheotomy is performed (*see* p 1700) and a Durham s tube inserted and connected up to an apparatus for the insufflation of the anæsthetic through a tube long enough to keep the anæsthetist outside the field of operation

A small lymphatic node sometimes two will usually be found lying on the crico-thyroid membrane. It is important to remove these nodes as they are on the path of lymphatic drainage through the crico-thyroid membrane from the subglottic portion of the larynx (Fig 710) These nodes should be submitted to the histologist.

Inhalation anæsthesia is now induced. It can be preceded by intravenous administration of pentothal, as the airway is clear Light anæsthesia with *Trilene* is adequate and is probably safer than chloroform The tachypnœa which it produces is advantageous to the patient and does not impede the surgeon. It is vitally important to maintain full oxygenation of the blood and attempts to continue anæsthesia by nitrous oxide alone with the risk of cyanosis are to be strongly condemned.

The perichondrium on the thyroid cartilage is now incised. The division may be mesial or a few millimetres from the middle line on the side opposite to the growth so as to avoid cutting into a growth which has invaded the opposite cord under cover of the anterior commissure The thyroid cartilage is split from below upwards in the line of this incision care being taken to avoid unnecessary damage to the anterior commissure with a view to conserving vocalization.

The divided alæ are held widely apart with a self retaining retractor A small sized Mollison s mastoid retractor or a Jansen s retractor is useful The points should be blunt or guarded with rubber in order to avoid damage to the divided edges of cartilage. The mucosa is now sprayed with a solution of 10 per cent cocaine and adrenaline and the surface of the growth painted with spirit A long ribbon of gauze is packed down into the trachea above the tube. The growth is always

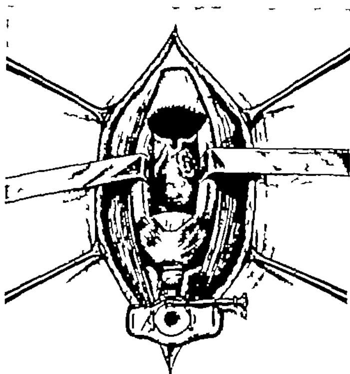


Fig 711.—Laryngo-fissure, showing intrinsic carcinoma of the left vocal cord and ventricular band.

infected and is also to be regarded as covered with cancer cells likely to be disseminated in the wound technique must be arranged in appreciation of these facts.

By some surgeons the alar cartilage of the affected side is freed from the perichondrium both within and without and is removed* with the exception of a small strip posteriorly This step facilitates examination of the growth and avoids the delay in healing otherwise caused by the granulating surface of the cartilage. It is possible however that the cartilage acts as a barrier to the spread of the growth should a recurrence arise in cases where the cartilage has been removed the growth will invade the soft tissues more rapidly For this reason a majority of surgeons do not remove the thyroid ala.

Removal of the growth —The perichondrium and thyro-arytenoideus muscle on the side of the growth are separated from the inner surface

St. Clair Thomson and Negus, "Diseases of the Nose and Throat," Cassell, 6th ed. 1955.

of the cartilage by some form of elevator as far backwards upwards and downwards as the instrument will pass with thin long scissors an incision through the mass of perichondrium muscle and laryngeal mucosa is carried round the tumour a margin of over ¼ in of healthy tissue being included If the growth involves the anterior end of the cord as much of this as is necessary must be sacrificed while posteriorly it may be necessary to remove part or all of the arytenoid cartilage If the vocal process only has to be removed no disturbance results but if the arytenoid is sacrificed the surgeon must be prepared for dysphagia and the inhalation of fluids with its attendant risk of pneumonia for some days afterwards. Bleeding occurs from the posterior raw area where the arytenoid branch of the superior laryngeal artery has been severed This bleeding point is easily secured and ligatured

Closing the larynx.—The packing having been removed the alæ are allowed to fall together accurate replacement being facilitated by approximation of the overlying muscles If necessary the halves are held together by catgut sutures through the perichondrium covering them and the wound is sutured *only as far down as the tracheotomy-tube* It is usual to leave the tracheotomy tube in position for twenty four hours with a view to avoiding the risks due to reactionary hæmorrhage.

After-treatment.—Patients should be nursed in a sitting position which facilitates breathing and the expectoration of mucus and blood After excision of a growth silence is imposed for ten days

Complications.—*Hæmorrhage* reactionary or secondary may occur and septic pneumonia following reactionary hæmorrhage has been the greatest cause of fatalities

Reactionary hæmorrhage can be largely obviated by ligature of the arytenoid branch of the superior laryngeal artery and by retention of the tracheotomy tube for twenty four hours Secondary hæmorrhage is rare especially since the practice of light insufflation of raw surfaces with penicillin and sulphonamide powder

Emphysema should not occur if that part of the wound below the tracheotomy opening is not sutured

Mediastinitis is a rare and fatal complication It is unlikely in patients who have been freed beforehand from infective processes in the teeth and the upper air passages It is due to the downward passage of infection from the operation area behind the pre-tracheal fascia and can be avoided to a large extent by drainage of the lower portion of the wound

In laryngo-fissure for stenosis the cavity of the larynx is restored by the submucous removal of all fibrous tissue care being taken to preserve any attached mucosa which is viable. Any raw areas remaining may be epithelialized either by skin-grafting or by some modification of the *pansement en cigare* followed by intubation as recommended

by Moure * He plugs the cavity with a cigar-shaped wad of tig rolled gauze for six weeks changing it occasionally A vulcanite t is worn for some months until epithelialization is complete. laryngeal cavity is then restored by plastic means.

Schmiegelow s Operation

The operation of choice for fibrous stenosis of the larynx is t devised by Professor E Schmiegelow of Copenhagen and described him in the Semon Lecture in 1937 † The principle of the operatio the fixation of an india rubber tube in the stenosis in such a way t the dilatation can continue uninterrupted for weeks or even mor without being changed and without any inconvenience to the patie Schmiegelow gives details of 18 patients operated upon by him betw 1909 and 1935 with a cure of the condition in all cases the minim follow up period being two years. In 15 cases the maximum per during which the tube was worn was 10 weeks with an average about six weeks. In 8 severe cases the treatment was continued 6 9 and 11 *months* Schmiegelow considers that the operat should not be performed in children aged less than five years as dimensions of the air passages are then too small and there is no urg *need for operation in such cases. Patients requiring* operation h tracheotomies at various levels—usually highly placed and often m accurately termed cricotomies. A first step is the performance o low tracheotomy operation A week later the stenosis is exposed laryngo-tracheal fissure. The fibrous tissue mass causing the steno is cut away and a rubber tube about 5 cm long is introduced, the tu being of such a diameter that it fits firmly into position. The up end of the tube should be situated just above the rima glottidis b below the ventricular folds so that the reflex closure of the adi laryngis is not prevented. The tube is fixed by passing a long curv needle through the soft parts the thyroid alæ and the tube a sil wire being drawn back and the wire being cut off so that the sever ends on either side recede just below the skin surface. *The laryn* deep fascia muscles and skin are then united in the midline. Af a period of some weeks the tube and its fixing wire are removed traction with Patterson s forceps by direct laryngoscopy or broncl scopy A patient operated upon by us had a retained tracheoto tube for 14 years following implantation of radium in infancy laryngeal papillomata. There was a solid mass of fibrous tissue at t level of the cricoid. Three years after operation he was an acti man of 25 able to swim and to play football, and with a useful vo which was that of a child of about 10 years the larynx having remain infantile in size and function. The high proportions of success results secures for this operation a permanent place in the history laryngeal surgery

* *Path. de Guerre*, 1917
† *Journ. Laryngol.*, lii, i, 1

It is possible now to obtain plastic tubing with a triangular cross section exactly conforming to the shape of the rima glottidis and by covering the outer surface of this tube with a Thiersch skin graft and closing the larynx over it the raw surfaces become epithelialized and the tube can be removed in two weeks.

2 Partial Laryngectomy

The first phase of an intrinsic growth is definable and indications for treatment are clear cut but when this stage has been passed, we enter on debatable ground Definition is difficult as is also the presentation and the interpretation of results Hautant* perceived

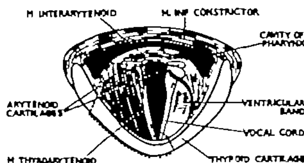


Fig 712.—Partial laryngectomy (Hautant) The parts removed are included within the dotted line.

a phase which may be more or less clearly defined and for which some form of partial laryngectomy is indicated, and has devised an operation which may be regarded as typical of all partial laryngectomies Hemi laryngectomy designed for the excision of half an organ rather than the removal of a disease has been discarded It destroyed the laryngeal functions including the prevention of inhalation of harmful substances Hautant's operation while meeting the indications of satisfactory excision of the growth recognizes that this is not incompatible with the preservation of the major part of the larynx with its functions

Operation. **First stage.**—Under local anæsthesia the larynx and trachea are exposed by an incision in the middle line from the hyoid bone down to the suprasternal notch.

Second stage.—Clearly a midline incision through the thyroid cartilage begs the question of unilaterality As it is very difficult to determine by laryngoscopy whether the growth has invaded the opposite side of the larynx by way of the anterior commissure an incision through the thyroid cartilage is made about 5 mm lateral to the incisura on the side remote from the growth. The membranous larynx is respected throughout this stage by careful separation of the muco-perichondrium from the cartilage A second incision through the thyroid cartilage on the side occupied by the growth is made as far lateral as is consistent with the preservation of some attachment

* Ombrédanne Traitement du Cancer Endolaryng 1930

for the inferior constrictor of the pharynx along the oblique line from the superior to the inferior thyroid tubercle The cricoid cartilage is now cut through in the middle line after a preliminary separation of the underlying muco-perichondrium followed by a second incision on the side of the growth as far lateral as the point where the cricoid suddenly begins to broaden The pieces of cartilage thus outlined are removed (Fig 712)

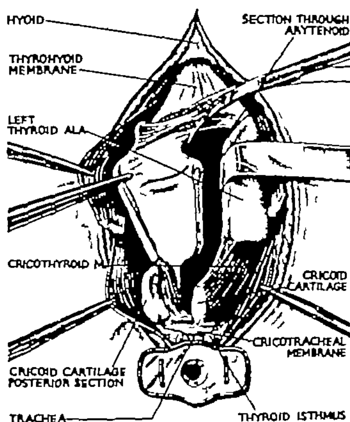


Fig 713 —Partial laryngectomy (Hautant).

Third stage.—Blunt dissection is made backwards to separate the membranous larynx from the cricoid cartilage. When the dissection reaches the arytenoids a crucial point in the operation occurs the arytenoid on the affected side being cut through so as to divide the processus vocalis from the main body of the cartilage. (Fig 713) This manœuvre ensures preservation of the inter arytenoid curtain, upon which the hope of future deglutition obviously depends

Fourth stage.—The lumen of the larynx hitherto preserved to limit the risks of infection is now entered and the growth accompanied by as much tissue as is necessary to guarantee a healthy margin is removed The portion ablated usually includes a small piece of the *opposite* cord the *vocal process of the* arytenoid the ventricle of the larynx and the ventricular band

Fifth stage.—The wound is closed and the patient is able immediately to take fluids. Although Hautant described tracheotomy as part of the operation it should not be necessary with intratracheal anæsthesia. A preliminary tracheotomy however is not detrimental to the technique nor to the success of the operation and the security which it affords is valuable

Results.—Obviously the operative mortality of partial laryngectomy will depend chiefly on the selection of cases Hautant (*loc cit*) had a post-operative mortality of 8 per cent and over 60 per cent of two-year cures the recurrences being only among those in which the mobility of the cord was impaired

8 Total Laryngectomy

Indications.—The criteria separating cases suitable for partial laryngectomy from those in which the whole organ must be sacrificed are not in their very nature clearly cut but commencing *thickening of the ary-epiglottic fold* is critical. It foreshadows invasion of the pyriform fossa of the pharynx with the free lymphatic spread which is the heritage of extrinsic growths and calls for laryngectomy Once a growth has bulged into the sinus pyriformis it is frankly extrinsic and is inoperable by laryngo-fissure More judgment is demanded in assessing the importance of spread in other directions

A *subglottic extension* if very small may still be removed by splitting the larynx invasion of the *perichondrium* or of the *crico-arytenoid joint* which leads to fixation of the cord is a clear indication for total laryngectomy but partial laryngectomy is often successful if mobility is only slightly impaired A *forward*-spreading growth is operable and can be removed by partial or complete laryngectomy so long as it has not perforated the cartilage under the anterior commissure When it has done so it tends to spread rapidly in the skin *en cuirasse* which not only negatives partial laryngectomy but does away with any hope of a healthy plastic closure. If the lymph nodes be invaded the operation should be planned so as to include a resection of the glands with the jugular vein on the affected side If the glands be not invaded they should not be removed as any subsequent metastases will occur in the tissue planes and be inoperable whereas if it occurs in the glands a subsequent operation may still be feasible Preliminary treatment will be carried out in order to eliminate any infective focus in the sinuses or teeth

Anæsthesia—The following details are supplied by Dr Stephen Coffin who has administered the anæsthetic in all the writer s cases at the Royal National Throat Hospital Golden Square

General considerations.—Patients are frequently bad risks and bronchitis and emphysema is their most common physical abnormality Post-operative pulmonary complications can easily occur and technique must be planned to provide a non toxic anæsthesia

with a cough reflex available throughout and an active cough at the end of the operation. Quick recovery must be aimed at and the patient should be sat up as much as can be done immediately after the operation or if not as soon after as is possible. A good airway with full oxygenation is essential. Post-operative aspiration of the trachea must be carried out Post-operative breathing exercises are essential and should be demonstrated to the patient before operation. A transfusion should always be put up of saline and later blood into which intravenous drugs can be injected

Methods. 1 *No pre-existing tracheostomy*—Endotracheal tube to be passed. Tracheostome fashioned at the end of the operation

2. *No pre-existing tracheostomy*—The surgeon prefers no endotracheal tube. Tracheostome fashioned at the end of the operation.

3 *No pre-existing tracheostomy*—Tracheotomy or alternatively a crico-tracheotomy or laryngotomy performed immediately before operation either under local analgesia or general anæsthesia.

4. *Where there is already a tracheostomy* crico-tracheostomy or laryngostomy

Choice.—If the airway is good any of the above methods are suitable. If the airway is bad a preliminary tracheotomy crico-tracheotomy or laryngotomy under local analgesia is essential general anæsthesia under these circumstances being hazardous

If the airway is moderate methods 1 or 3 are suitable or possibly method 2 if the surgeon is prepared to do an immediate tracheotomy if needed, during the early stages of the operation

Technique.—Premedication Atropine gr $\frac{1}{100}$ (hypodermic)

Method 1—An oral endotracheal tube as large as convenient, is passed under thiopentone and a relaxant The tube can be cuffed or not but with good surgical technique blood does not enter the trachea when the larynx then raised is opened Maintenance is with nitrous oxide oxygen and minimal trilene (oxygen at least 30 per cent) and intravenous pethidine with or without thiopentone After the larynx is opened the endotracheal tube is removed and a sterile 8-in long cuffed tube on a 6-in. long catheter mount is inserted in its place or if the surgeon finds this inconvenient anæsthesia is maintained on intermittent doses of intravenous drugs only until the larynx is removed when the short cuffed tube can be used When the stoma is being fashioned intravenous anæsthesia alone must be relied upon after which the short cuffed tube can be replaced Anæsthesia can be very light especially towards the end of the operation when very little will be necessary

Method 2—After induction with thiopentone a thyroid mask with harness is used maintenance being as in method 1 Fit of mask and control of airway can be awkward. After the larynx is opened

inhalation anæsthesia must be abandoned and intravenous only relied on until the surgeon finds it convenient for a short cuffed tube to be used when one proceeds as in method 1

Method 3 —If tracheotomy is performed under local analgesia the patient is induced with thiopentone as the trachea is about to be opened if under general anæsthesia nitrous oxide oxygen and trilene with a thyroid mask after a thiopentone induction will suffice until the trachea is opened and a short cuffed tube can be inserted Maintenance is then as before If a crico-tracheotomy or laryngotomy

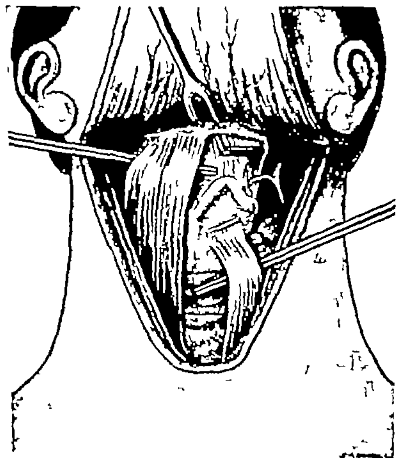


Fig 714 —Laryngectomy The skin flap has been retracted. The muscles are detached from the hyoid bone and thyroid cartilage.

(From Thomson and Negus, " Diseases of the Nose and Throat," Cassell, 5th ed. 1948.)

has been performed the lesser space available will necessitate the use of a Magill connector or preferably a specially designed tracheotomy tube with an upper right angled end on a long catheter mount

Method 4 —Sufficient thiopentone is given to enable the short cuffed tube to be passed into the tracheostome the tracheotomy tube having been previously removed anæsthesia then being continued as in method 3

Operation (*a*) **Incision**.—A bucket-shaped incision is made from the tip of the greater cornu of the hyoid on each side obliquely downwards to the horizontal incision at the level of the first ring of the trachea. The angles at the lower end of the flap are defined by affixing Michel's clips to the skin edges at the points at which they are to be reunited at the end of the operation. A full thickness flap which includes the platysma is turned upwards being limited by the attachment of the deep fascia to the hyoid bone. The carotid sheath on each side is next defined and if invaded lymph nodes are found a block dissection will be undertaken.

(*b*) **Freeing the larynx**.—The infra hyoid muscles are clamped immediately below the hyoid divided stripped downwards and



Fig 715.—Total laryngectomy The inferior constrictor fibres are being divided by the scalpel at their origin on the thyroid cartilage.

removed. The superior thyroid artery will be encountered as it enters the upper pole of the thyroid gland. If the gland is large it may cover a large part of the ala of the thyroid cartilage and it will be necessary to dissect it away from the larynx. If a pyramidal lobe be present it must be removed. The larynx is now drawn forwards and rotated by blunt hooks placed around the posterior border of the ala the right side usually being freed first and the origin of the inferior constrictor muscle along the oblique line is defined. The inferior constrictor being detached from its origin with a scalpel is divided with scissors together with the pharyngeal aponeurosis as far as the lower border of the cricoid cartilage exposing the pharyngeal mucosa bulging with respiratory pressure. The superior laryngeal vessels are next secured and divided and the exposure of the mucosa is carried

upwards to the level of the hyoid bone This mobilization of the larynx is now repeated on the opposite side

(c) Opening the pharynx.—The pharynx is now opened at the level of the *thyro-hyoid membrane* In all cases of supraglottic primary growth or with supraglottic extension the body of the hyoid should be removed. With the pharynx opened on both sides it is easy to remove the body of the hyoid by cutting vertically upwards with strong scissors or with shears The two openings in the pharynx are now joined by a transverse incision between the epiglottis and the base of the tongue The larynx is now pulled forwards by grasping the base of the epiglottis in a Lane s forceps and the growth can be inspected.



Fig 716 —Total laryngectomy The muscular and aponeurotic pharyngeal wall are held by dissecting forceps. The shining mucous coat is seen bulging on expiration.

The pharyngeal wall is now divided on each side from above downwards as much mucosa being preserved as the extent of the growth permits The two lateral incisions are joined across the posterior surface of the cricoid cartilage and the hypopharynx is dissected off the cricoid until the upper end of the œsophagus is defined An *œsophageal branch of the inferior thyroid artery* is encountered on each side when dividing the tendons of insertion of the longitudinal muscles of the œsophagus.

A rubber œsophageal tube is next introduced into the œsophagus the upper end being passed into the oropharynx where it is received by a nurse and brought out through the mouth The tube should not extend beyond the middle of the œsophagus because any foreign body at the lower end stimulates the cardiosalivary reflex and profuse salivation is produced The pharyngeal mucosa is now carefully

united from below upwards with interrupted sutures of medium chromic catgut size 2/0 B P C mounted on an eyeless curved needle The sutures should invert the mucosa. The upper end of the reconstituted pharynx is anchored to the base of the tongue. The inferior constrictors are united over the repaired mucous coat.

(*d*) **Removal of the larynx.**—The trachea is divided as high as possible. With subglottic growth two or three rings may be sacrificed in order *to obtain a margin of uninvaded tissue The anterior wall is divided* horizontally and the trachea fixed by two strong silkworm-gut sutures to the lower horizontal edge of the skin incision The clips placed at the angles will enable the trachea to be anchored accurately in the centre. The larynx is now completely removed

(*e*) **Closure of the wound.**—It has been the writer s practice for the last five years to close the wound without drainage Before replacing the skin flap the whole raw surface is frosted with penicillin and sulphathiazole powder The flap is next fixed in position by deep catgut sutures until the angles of the flap are restored to their position in the angles of the wound as defined by the metal clips The deep surface of the flap in the midline is sutured to the reconstituted pharynx The edges of the skin and trachea are now closely approximated with black silk the same material being used to unite the skin edges A Lombard s tracheal tube is inserted and the wound dressed with layers of gauze a tight bandage being applied The bandage should be just so tight as to produce slight cyanosis in the lips and the lobules of the ears The tissue planes are thus firmly held in apposition and no spaces are allowed to exist into which saliva might track later After two hours the bandage is relaxed until there is no trace of cyanosis The œsophageal tube is removed after the bandage has been applied.

Post-operative care.—As soon as possible after his return to bed the patient is nursed in a sitting position as this greatly assists in the avoidance of pulmonary complications The patient is given feeds consisting of milk to which eggs and meat extracts are added, according to the following formula drawn up by the Professional Staff of the Royal National Throat Nose and Ear Hospital. Systemic penicillin is administered for the first seven days

DAILY FLUID FEED FORMULA
(2 500 cals basic)

A milk mixture with added vitamins electrolytes and iron

Make up for 24 hours as follows —

Milk		68 oz
Glucose		6 oz.
Eggs		8 oz.
Casilan		8 oz.
	Total	75 oz.

To this add —

Abidec	20 m
Benerva	2 tablets
Nicotinamide	1 tablet
Ascorbic acid	200 mgms
Ferri et Ammon Cit	20 grs
Sodium Chloride	2 5 gms

Analysis —

Carbohydrate	288 gms	Vitamin	A	12 760 I U
Protein	153 gms		B_1	4 96 mgms
Fat	85 gms		B_2	8 65 mgms
Calcium	3 252 mgms		Nic	51 mgms
Iron	5·4 mgms		B_6	1 0 mgms.
NaCl	5 8 gms		C	272 mgms
			D	2 009 I U

Total calories 2 527

To be given in approximately 9 two-hourly feeds of 8 oz each with one additional feed of fruit juice or beer midday or at night. Some 8 oz. or more of tap water to be given with each feed Total daily fluid intake should be not less than 5 *pints*

The dressing should be left undisturbed for a week unless suppuration or leakage of fluids occurs In most cases the patient can take fluids readily by mouth The tube can be reinserted for feeding or supplementary feeding in cases of difficulty but it is seldom required after the first two days. A normal diet can be given after four to six days Speech therapy is instituted as soon as possible and the rudiments of pharyngeal speech are often acquired in a few days The stitches should be removed on the seventh day Healing by first intention occurs in the majority of cases Freedom from infection and from fistulæ depend upon the use of chemotherapy and antibiotics the discontinuance of drainage and the early removal of the œsophageal tube

The **results** of laryngectomy for intrinsic cancer vary between 56 per cent of 5-year cures reported by Waugh* to 85 per cent. of 3 year cures reported by Hajek † The mortality (chiefly due to inhalation pneumonia) was originally prohibitive MacKenty however reduced it to 3 per cent by adopting Solis-Cohen s method of isolating the trachea and bringing its orifice out on to the neck More recently New‡ published 65 cases with only one death In 1948 the late Lionel Colledge gave his results to date.§ There were 60 cases of laryngo-fissure and partial laryngectomy with 2 deaths and 78 per cent of the

* *Surg. Gyn. Obst.* 1934, lviii, 851
† *Mschr. f. Ohrenh.*, 1933, lxix, 385.
‡ *Trans. Amer. Med. Ass.*, (Laryngol. Sect.), May, 1936, lxxxvii, 262.
§ Lettsomian Lectures, *Trans. Med. Soc. Lond.* Ibid, 300–83.

patients alive and well 10 years or more later Also 140 total laryngectomies with 19 deaths and 60 per cent. alive and well 10 years or more later

DIATHERMY

Many *surgeons (New * Broyles (loc cit)) combine thyrotomy with* diathermy in early cases while Lynch† combined diathermy with excision via the direct laryngoscope

IRRADIATION

Irradiation in various forms has certain advantages particularly in rapid growths showing anaplasia and mitosis It may be used in conjunction with surgery Broyles (*loc cit*) quotes 26 cases at John's Hopkins Hospital and says that the only cases which were really cured were those in which complete removal by laryngectomy had been followed by irradiation. He does not say by what means. The means would however appear to be an important factor for while Harmer and Finzi‡ found that 6 out of 8 cases of intrinsic carcinoma were well from one to three years after the implantation of radium needles Levitt (1927) in a personal communication reports only two 8-year survivals out of 7 cases of intrinsic cancer treated by X rays from 1924 to 1932 while Stewart Harrison§ reports 6 cases out of 15 well for 8 years after Roentgen treatment Lambert and Watson‖ report promising results in 11 cases of unilateral growths treated by contact X rays applied immediately after removal of thyroid ala. Further figures are given in a later report ¶ but it is still considered that the method requires further trial particularly in the adjustment of the physical factors of the X rays in order to produce a higher depth dose.

Technique —Where it is possible to expose the whole growth to radium platinum iridium needles containing radium bromide or radium emanation are implanted. The containers usually have a unit linear intensity of ½ mg of radium element per cm of active length to ensure a lethal dose to a cylinder of tissue about 2 cm in diameter after about seven days exposure.

Filtration is of extreme importance damage to normal tissue cannot be avoided unless the wall of the container is 0·6 mm. thick or more Whereas needles can in other parts of the body be inserted through the skin in laryngeal cases it is necessary surgically to expose the area involved care being taken to keep the wound aseptic by keeping out of the lumen It was formerly considered that removal of more than one third of the circumference of the cartilage of the larynx or trachea would inevitably cause collapse and consequent

* *Trans. Amer Med Ass* (Laryngol Sect) May 1936, lxxxvi, 222.
† *Trans. Amer Laryngol* 4 ssc 1920 xlii, 119
‡ *Brit. Med. Journ.*, 1929, ii, 600 § *Journ. Laryngol Otol.* 1932 xlvii, 725. ‖ *Ibid.*, No. 4, 1942, lvii, 222.
¶ *Journ. Laryngol.*, 1945, X, iv 174

obliteration of the airway But it has been found possible to remove the whole of the narrow part of the cricoid as well as practically the whole of one ala of the thyroid and a considerable portion of the other without noticeably prejudicing the airway

It is therefore possible adequately to expose all the antero-lateral parts of the larynx to irradiation and an operation for the implantation of radium needles for a carcinoma involving the whole of the vocal cord has been successfully carried out (Fig 717) with disappearance of the growth for 2½ years The cartilaginous removals here shown are an extension of those employed by Hautant in his Laryngectomies Economiques

After the removal of the cartilage the growth may often be seen shining through the underlying perichondrium which is carefully respected The needles are laid upon it their inactive portions often being tucked under a neighbouring edge of cartilage and the wound closed. Their removal a week later does not require an anæsthetic

Shrinkage of the growth is usually evident even before the needles are removed and intrinsic carcinomata disappear within three weeks as a rule

Treatment should include diathermic removal of the successfully irradiated area when feasible

We are indebted to W D Harmer for the following notes about the Finzi Harmer operation The method is a modification of an earlier procedure described by Ledoux (Brussels)

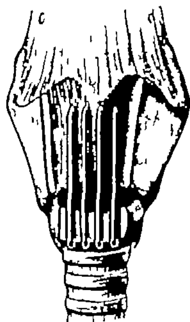


Fig 717 —Implantation of radium needles for intrinsic carcinoma.

An intact perichondrium is important as if it is invaded the growth becomes extrinsic and cannot be cured by needling alone A large fenestra is made in the ala of the thyroid cartilage on the affected side with a frame of residual cartilage on three sides—the inner perichondrium being maintained intact The upper rim of the cricoid cartilage is similarly removed Nine or more milligrammes are inserted e g four needles of 2 mg 44 mm long in a vertical plane and one or two of 1 mg 27 7 mm long transversely The filtration is 0 8 mm of platinum If retained for a week the dose is roughly 6 000 r The needles are firmly fixed with sutures. The two in front should be farther apart than the others as here the dose is likely to be too high Extensive cancers involving both cords require bilateral fenestration Of fifteen patients so treated nine died within 2 years two in 5 and 10 years from recurrences Four are living two for 2 years one for 8 years and one for 23 years

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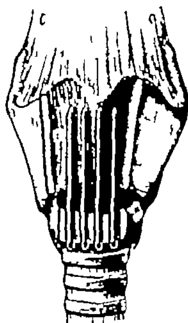


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CARCINOMA OF LARYNX 1924–46

113 PATIENTS TREATED BY FENESTRATION AND RADIUM NEEDLING

	Cases	Op. Deaths	Died of Cancer	But Lived Years 1	2	3+	5+	Died Free of Recurrence	Years After Treatment 1	2	3+	5+	10+	Living Free of Recurrence	Years After Treatment 5+	10+	5-Year Survival Rate
Early	28	1	4	—	2	—	2	16	—	2	2	6	6	7	4	3	75% 21 out of 28
Advanced	85	7	40	27	11	5	6	16	1	1	1	6	7	13	9	4	38% 32 out of 85
All Cases	113	8	44	27	13	5	8	32	1	3	3	12	13	20	13	7	47% 53 out of 113

MANAGEMENT OF EXTRINSIC GROWTHS

The treatment of extrinsic growths is unsatisfactory Few surgeons advocate excision, and many report disappointing results from the implantation of radium needles Souttar* stresses the importance of accuracy and uniformity of dosage and has elaborated a method of implanting two opposing plaques of dental wax in which radium needles are imbedded this gives a uniform dose of radium to the whole of the desired area. Victor Lambert† records good results from the use of contact irradiation in largyngeal carcinoma. Details will be found in his paper

The late results of treatment by X rays is very disappointing Levitt (1937) reports five 8-year survivals out of 94 cases treated between 1924 and 1932 and two 5-year survivals out of 67 cases. Lederman reviews the results of radiotherapy from 1921 to 1944 in a paper read at the Royal Society of Medicine February 2nd 1945 ‡ The immediate results are amazingly good in the majority of cases there is disappearance of the growth for over 12 months.

Acute œdema as an immediate complication and perichondritis with necrosis of the cartilage later are both apt to occur in spite of care. Bold surgery is again coming into the field and probably *has more* to offer than other methods Lionel Colledge (*loc cit*) reported many encouraging examples Ormerod in the Semon Lecture 1953 presents a comprehensive study of the management of cancer of the larynx.§

* *Brit. Med Journ.*, May 1 1937 i, 909

† *Journ. Laryngol. Otol* April, 1942, lvii, 222.

‡ *Journ. Laryngol.*, X v 221; *Brit. Journ. of Radiol.*, 1952, xxv 297

§ *Journ. Laryngol Otol.*, lxviii, 1, 1 27

CHAPTER XXXI

INVESTIGATION OF THE UPPER AIR AND FOOD PASSAGES

By SIR VICTOR NEGUS and G GREY TURNER

DIRECT LARYNGOSCOPY, PHARYNGOSCOPY, BRONCHOSCOPY AND ŒSOPHAGOSCOPY

Surgical anatomy —In an endoscopic examination the following are the chief points of anatomical interest The *epiglottis* lies at the base of the tongue and is a necessary landmark in direct inspections Its lateral margins are continuous with the *ary-epiglottic folds* which meet posteriorly and form the boundaries of the laryngeal aperture Approximation of the folds against one another associated with their apposition to the epiglottis and base of the tongue closes the larynx during swallowing The internal aspect of each ary-epiglottic fold is continuous with the *ventricular band* of which the free lower margin forms the upper boundary of the *ventricle* Below the latter lies the *vocal cord* a broad white fold stretching from the thyroid cartilage anteriorly to the arytenoid cartilage posteriorly

The trachea is 11 cm (4½ in) long it bifurcates at the level of the second costal cartilage into the right and left main bronchi. *The right main bronchus* is shorter wider and more nearly continuous with the trachea than that of the other side it gives off the upper lobe bronchus and the middle-lobe bronchus and continues as the bronchus to the lower lobe. *The left main bronchus* is longer than its fellow and is given off at a greater angle from the trachea it divides into two branches the upper lobe bronchus and the lower lobe bronchus

The septum between the right and left main bronchi the carina is situated to the left of the middle line When viewed through the bronchoscope it appears as a sharp ridge on either side of which are seen the openings of the main bronchi

Direct Laryngoscopy and Pharyngoscopy

These two examinations may be described together as they entail the same technique and the use of the same instruments The larynx and pharynx should always be examined indirectly with a *mirror* before making the direct examination.

Indications for use of laryngoscope.—

(1) Removal of a foreign body from the base of the tongue or from the larynx.
(2) Examination of a neoplasm of lower pharynx or larynx and for biopsy
(3) Examination and treatment of laryngeal stenosis
(4) Treatment of laryngeal diphtheria.
(5) The insertion of a tube for endotracheal anæsthesia.

Technique.—The direct examination is carried out by means of a laryngoscope or speculum either of the Chevalier Jackson type in which the light is distal or of that designed by Brünings and modified by Kahler and Haslinger in which the electroscope is in the handle The former type is preferred as the passage of instruments down the tube does not cut off the illumination Laryngoscopes of the type devised by us are efficient the light is derived from twin lens-fronted lamps placed obliquely on either side of the laryngoscope at its proximal end (Negus 1932) Œsophagoscopes are made on a similar principle.

Position of patient.—The laryngoscope is passed with the patient lying on an operating table with the head supported by the hand of an assistant or preferably by a mechanical head rest

Anæsthetic.—If the pharynx and larynx of an adult patient are painted with a 10 per cent. solution of cocaine to which an equal part of adrenaline has been added this will suffice in most cases it is also of advantage to allow a tablet of amethocaine (*Decicaine*) *to lie on* the patient s tongue and to dissolve slowly In some cases a general anæsthetic is necessary In the former case a preliminary injection of omnopon gr $\frac{1}{3}$ and scopolamine gr $\frac{1}{150}$ should be given one hour and a half before the examination the omnopon may be repeated half an hour before operation unless the patient is very drowsy For children nembutal is suitable for premedication general anæsthesia is usually required

Passing the laryngoscope.—The patient is placed in the recumbent position with the head so raised that the occiput is 10 cm (4 in.) above the level of the table the head is well extended The instrument is passed over the dorsum of the tongue until the epiglottis is identified the hypopharynx and pyriform fossæ can then be inspected. *The tip* of the tube is next passed behind the epiglottis when the interior of the larynx will come into view Care should be taken in introducing the tube that the patient s upper lip is not caught between it and the upper teeth In some cases in which the upper incisor teeth are very prominent the tube may with advantage be introduced through the side of the mouth. If there is difficulty in inspecting the anterior extremity of the vocal fold a narrower tube the anterior commissure laryngoscope may be used. Its beak can be inserted between the ventricular bands for close inspection of the vocal folds.

BRONCHOSCOPY

Indications.—

(1) Removal of foreign bodies lodged in the air passages
(2) Dyspnœa in which some obstruction of the air passages is suspected, either from narrowing of the passage itself or from pressure from outside by mediastinal new growths.
(3) Examination and treatment of cases of acute laryngo-tracheo-bronchitis bronchial abscess lung abscess and bronchiectasis.

(4) Diagnosis and treatment of new growths of the trachea or bronchi

(5) In new growths of the œsophagus to detect commencing invasion of the bronchial tree (the tracheoscope an abbreviated bronchoscope is useful for this purpose)

(6) Bronchospirometry for estimating the functional activity of either lung

Instruments.—The following instruments are essential others may be needed for special cases bronchoscopes of five sizes for adults adolescents children infants and sucklings long swab-carriers a suction apparatus with bronchial suction tubes and bronchoscopic forceps of various types for removal of foreign bodies and for biopsy

BRONCHOSCOPES OF NEGUS TYPE

Size	Outside Diameter	Transverse Inside Diameter	Inside Diameter Over Lamp	Circumference	Length
	mm.	mm	mm.	mm.	cm.
Adult	11·0	10 0	8 7	35·0	40·0
Adolescent	9·0	8·0	6 7	29·0	40·0
Child	8·0	7·0	5 7	26·0	30·0
Infant	6·0	5 4	4 1	19 5	27 5
Suckling	4 8	4 1	3 2	15·0	27 5
Lower bronchus	7·0	6 4	5 1	22 5	45·0

Position of patient.—The position of the patient is the recumbent posture with the head raised (Fig 718) When the tube is just above the bifurcation of the trachea the surgeon may by bending the head towards one or other shoulder bring the long axis of the tube into that of either bronchus and so facilitate the passage of the beak of the tube into the corresponding bronchus

Analgesia and anæsthesia.—Bronchoscopy can be carried out under local analgesia with little discomfort to the patient if omnopon and scopolamine are given beforehand and if the pharynx and larynx are prepared with cocaine In children rectal paraldehyde is of value followed if necessary by inhalation anæsthesia Adults can if essential be given avertin followed by some general inhalation anæsthetic or a combination of local analgesia and pentothal may be used

Passing the bronchoscope.—The operator stands at the head of the table and the instrument is passed under direct vision through a laryngoscope The laryngoscope is introduced in the midline over the tongue until the epiglottis comes into view It is then directed

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behind the epiglottis and the bronchoscope is passed through it with the beak of the tube parallel with the vocal folds the bronchoscope is passed gently between the folds into the trachea. The laryngoscope is then removed after withdrawing its slide Under certain conditions it is preferable to pass the bronchoscope directly without the use of the laryngoscope it is sometimes easier to introduce it through the angle of the mouth. When the bifurcation is reached the carina

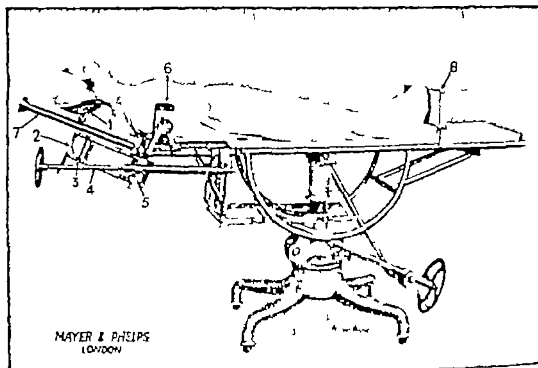


Fig 718 —Position for bronchoscopy with Negus head rest.

1 Padded cup to support head. 2. Screw to adjust height of cup for head. 3 Cam to control distance of head support from table. 4 Sterilised wheel for elevation or depression of head. 5 Lock to control lateral movements. 6 Padded, adjustable supports to control movement of shoulders 7 Sterilised quiver for instruments. 8. Foot rest.

and both bronchial orifices are carefully inspected before advancing the tube into either bronchus If the left bronchus is to be entered, the patient s head must be inclined towards the right shoulder if the right towards the left shoulder Examination of the bronchi must be systematic and careful and the orifices of the secondary bronchi must also be inspected The secretion which in some cases is profuse should be removed by suction or by sponging

Foreign bodies.—Smooth foreign bodies should be grasped with appropriate forceps and withdrawn slowly together with the tube. Sharp-pointed objects such as pins and staples should be dealt with very carefully and no force used in their extraction otherwise irreparable damage may be done if the point is embedded in the wall of the bronchus The pointed end should first be disimpacted by

forceps and manipulated into the mouth of the tube held in this position the foreign body and the tube may safely be withdrawn together Friable vegetable foreign bodies may be removed with delicate grasping forceps small detached fragments are dealt with by aspiration with an electric suction pump

Neoplasms.—A small snip for microscopical examination may be removed with punch forceps Occasionally this is followed by smart hæmorrhage which should be arrested by the pressure of a swab saturated if necessary with 1 in 1 000 adrenaline or with 10 per cent protargol

EXAMINATION OF THE ŒSOPHAGUS

Surgical Anatomy

The œsophagus begins at the level of the sixth cervical vertebra behind the cricoid cartilage The level of demarcation from the hypopharynx is at the crico-pharyngeal fold This fold is produced by the contraction of the crico-pharyngeal sphincter constituted by the lowest fibres of the inferior constrictor muscle. In the average adult the œsophagus begins 14 to 16 cm (5 to 6 in) from the upper teeth and passes through the thorax to join the stomach 3 to 5 cm (1½ to 2 in) below the diaphragm Its total length is usually about 23 to 25 cm (9 to 10 in) but it may be as much as 28 cm It is convenient to speak of the normal points of narrowing in distances from the upper teeth. These points are found at the crico-pharyngeal fold 14 to 16 cm. (5 to 6 in) at the level of the aortic arch 23 cm. (9 in) at the point where the left bronchus crosses 27 cm (11 in.) and at the diaphragmatic hiatus opposite the tenth dorsal vertebra 36 to 40 cm (15 to 16 in) The upper end of the œsophagus is in the mid line but its direction is slightly to the left before it passes between the crura of the diaphragm

It may be regarded as a long strap-like hollow muscle The walls are thin 3 to 4 mm (3/16ths in) and consist of an external fibrous coat an outer longitudinal and an inner circular muscular coat a well marked submucous layer of areolar tissue and an internal mucous membrane of squamous-celled type In the mucous membrane there may be areas of heterotopic gastric type. The tube lies in a bed of loose cellular tissue in which it can move freely during swallowing and body movements. In parts this cellular tissue is dense and forms ligamentous connections with the left bronchus and the arch of the aorta but for the most part it is a soft loose bed in which the finger can easily travel with little resistance.

The important relationships are anteriorly the trachea and left bronchus which crosses it the pericardium and the left vagus nerve posteriorly the cervical and thoracic vertebræ thoracic duct descending aorta and right vagus laterally the pleura the arch of the aorta on the left and on the right the arch of the azygos vein The recurrent laryngeal nerves lie in the groove between the œsophagus and trachea

heart and mediastinum may be required because pathological conditions in these organs may sometimes cause distortions by pressure or displacement

Radiography

Radiography is of great assistance in diagnosis and may be most helpful in deciding on treatment The lumen of the gullet may be outlined by barium swallowed as a cream or thick paste or taken as biscuits Actual observation of opaque material seen by the screen must always supplement the films taken In the cervical region a carcinoma of the œsophagus can be shown in outline by a soft tissue radiograph here too perforation may be revealed by the presence of air between the posterior œsophageal wall and vertebral column. The bulk of a growth may lift the trachea forward and this will be demonstrated by the outline and the displacement of the column of air in that tube

Pouches are usually well shown but views in different positions must be made In stricture the œsophagus above the obstruction fills with opaque material and defines the upper border thus showing whether the lumen is regular and tapering or irregular in outline The former is characteristic of simple and the latter of malignant disease The stricture itself will be delineated but the œsophagus below this level may not be well defined If the position and outline of the lower limit of the obstruction is to be demonstrated the patient must swallow barium while reclining and then adopt the Trendelenburg position immediately the opaque material has passed through the stricture This causes the barium to flow back and fill the lower segment of the œsophagus thus affording additional information. This technique is particularly useful in cases of short œsophagus with intra thoracic stomach The X rays also demonstrate the degree of dilatation above an obstruction and so provide some indication of the duration of the disease in achalasia the œsophagus may be enormous but in malignant disease there has seldom been time for it to become much dilated

Bougies

Sounding the œsophagus has been largely discarded in recent years in favour of radiography and direct examination which in the hands of those specially trained and experienced give much more accurate information with less danger But these special methods may not always be available or in the hands of the inexperienced may be more dangerous than bougies The soft mercury filled bougie associated with the name of Sir Arthur Hurst traverses the œsophagus by its own weight and can on occasion be used to determine the presence and site of an obstruction and to give some indication of its nature it is a safe instrument

Œsophagoscopy

Œsophagoscopy is an accurate means of diagnosis and is often most useful in treatment but in the hands of the unskilled it may be

dangerous and deaths from injuries and perforation of the œsophageal wall have occurred Practically the only contra indication is well developed aneurysm of the aorta In advanced malignant disease œsophagoscopy may serve no useful purpose and may indeed precipitate some such complication as hæmorrhage or perforation On the other hand by permitting visual dilatation it may be the means of re-establishing the power of swallowing

Indications for œsophagoscopy —

(1) Removal of foreign bodies
(2) Diagnosis and treatment of simple strictures including those due to congenital abnormalities
(3) Diagnosis and treatment of simple and malignant neoplasms
(4) Diagnosis and treatment of œsophageal varices
(5) Diagnosis and treatment of peptic ulceration
(6) Treatment of œsophagectasia (achalasia or cardiospasm)

Instruments required.—1 **The operating table** must be steady it is much more useful if it can be raised lowered and tilted A mechanical head rest is a help as it dispenses with the need for a specially trained assistant and leads to accuracy in instrumentation. We have introduced such a rest which simplifies the technique of peroral endoscopy (Figs 716 and 721) It is similar in principle to the apparatus of Haslinger but is rather more elaborate. It can be clamped on to most operating tables and consists of a movable extension carrying a padded cup to support the head A sterilizable wheel enables the operator to raise and lower the patient s head to whatever height is desired while lateral movements also can be made (*See* Fig 716)

If the œsophagoscope is to be passed into the lower œsophagus the patient s head must be depressed the whole table is then elevated by a foot pump or is in addition tilted so that the operator can see clearly down the œsophagoscope without having to crouch The mechanical head rest has the further advantage of maintaining the head accurately in the desired position for an indefinite period

2 **Tubes for examination** include short specula for use at the mouth of the œsophagus and longer tubes for the middle and lower regions. Various lengths and sizes are required for different ages and a complete set is expensive The following table gives the dimensions of our tubes that are most useful

Size	Outside Diameter	Inside Diameter	Circumference	Length
	mm.	mm	mm.	cm
Adult long full lumen	18 × 20	15·6 × 17·6	60	45
Adult long medium lumen	14 × 16	11·6 × 13·6	48	[illegible]
Adult short	16 × 18	13·6 × 15·6	55	35
Child	10 × 12	8·0 × 10·0	35	35

Specula and œsophagoscopes of Chevalier Jackson s type are illuminated by a small electric bulb placed in a groove near the distal end those of Brünings Kahler and Haslinger have a lamp in the handle and a mirror to reflect the light along the tube We have introduced tubes in which the illumination is supplied by twin lens-fronted lamps set obliquely into the walls near the proximal end. By this means a powerful light is given without danger of obscuration by secretions and with ease of sterilization and instrumentation. The useful sizes are given in the table

Œsophagoscopes of Jackson s type are also required for instance in congenital short œsophagus when it may be necessary to pass a narrow endoscope through the stricture to inspect the interior of the thoracic stomach. These instruments with their distal lighting are used in two sizes. We have modified the Jackson instruments slightly making them with an expanded upper end and with an attachable proximal projector

An œsophagoscope in addition to the features already mentioned, must —be well balanced and not unwieldy have an unobstructed lumen be sufficiently large to hold the œsophagus open and to give a comprehensive view be strong enough not to be easily dented by the patient s teeth and be sterilizable in all its parts

8 An efficient **suction pump** is required the mechanism may be outside the operating theatre or the whole apparatus may be portable preferably electric or failing this dependent on water power Great care is required with portable electric pumps to avoid ignition of anæsthetic vapour by sparking Rubber tubing connects the pump to a metal suction tube either built into the walls of the œsophagoscope or inserted through its lumen Specially prepared swabs must be at hand to suit the various sized tubes They are carried on holders of Chevalier Jackson s pattern.

Preparation of the patient.—Before œsophagoscopy the patient should have a general overhaul and also local examination of the nose pharynx and larynx A radiographic examination is also essential. If any incision of the œsophageal walls is contemplated strict attention must be paid to the condition of the mouth Dental sepsis must be eliminated and before certain operations all carious teeth should be removed if time permits the remaining teeth may be scaled and made scrupulously clean

If the œsophagus is much dilated it should be washed out an hour or two before examination particularly if general anæsthesia is to be employed A large stomach tube is used with a funnel through which boracic lotion may be run in and then siphoned back or aspirated by means of a suction pump The condition of patients who are dehydrated as the result of obstruction must first be improved by the administration of fluid either by rectum or subcutaneously or through a rubber catheter passed into the œsophagus

Position of patient.—The patient lies down as this permits greater ease of examination and also avoids irritation of the trachea by over

flow of saliva from the pharynx He is put in the Boyce position that is to say with half the scapula projecting beyond the end of the operating table the head being supported by a mechanical rest or held by an assistant (Fig 721)

Anæsthesia.—For the majority of œsophageal examinations general anæsthesia is desirable especially when wide bore tubes are employed It is safer if a sharp foreign body is lodged in or near the crico-pharyngeal fold as restlessness and contraction of the sphincter increase the risk of laceration of the œsophageal walls from instrumentation. Absence of contraction can be facilitated by the use of a relaxant In cases of malignant stricture general anæsthesia is merciful and is

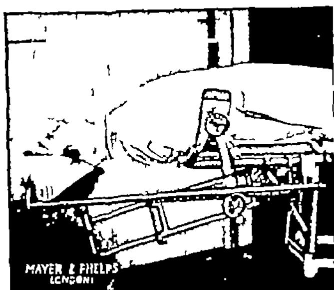


Fig 721 —Head rest for peroral endoscopy
Position for œsophagoscopy

particularly called for if delicate manipulations are to be carried out when immobility and relaxation are essential

Local analgesia may be employed in certain adult cases particularly where there is wide dilatation when general anæsthesia might be accompanied by regurgitation of food débris into the trachea.

In any case a preliminary injection of some sedative is required one hour before operation omnopon and scopolamine are recommended in suitable doses according to age and general condition For an adult the dose is omnopon gr ⅓ scopolamine gr $\frac{1}{150}$ This is followed by the use of a tablet of amethocaine and by painting the lips gums tongue pharynx and pyriform fossæ with 10 per cent. cocaine mixed with equal parts of 1 1 000 adrenaline about 60 to 120 minims of the mixture is required Decicaine 2 per cent may be used if preferred but in our experience is not so effective The part requiring greatest attention is the sinus pyriformis in which the swab carried on a long holder should remain for half a minute It is important to

avoid using any excess of cocaine for fear of poisoning The solution recommended causes rapid constriction of superficial capillaries whereby absorption is avoided if any of the solution is swallowed, however there may be absorption from the stomach with symptoms of poisoning The characteristics are a feeling of faintness weakness and possibly vomiting and nausea associated with pallor sweating rapid breathing and feebleness of the pulse The appropriate treatment is to give the patient a diffusible stimulant such as a drachm of sal volatile in an ounce of water or alternatively some brandy or whisky In severe cases 1 or 2 c.c. of pituitary extract should also be given hypodermically

General anæsthesia is usefully preceded by basal analgesia in the form of nembutal by mouth or paraldehyde per rectum for children for adults intravenous pentothal is used followed by intratracheal administration of gas and oxygen possibly combined with a very small quantity of trilene or chloroform Care and skill are required for this method but in expert hands the results are most satisfactory This form of anæsthesia obviates any possibility of explosion

Technique of œsophagoscopic examinations. Position.—The method to be described is that in which the patient lies in the dorsal position with the head supported The occiput should be 10 cm above the level of the table The head must be extended to bring the mouth as nearly as possible into line with the axis of the gullet.

In introducing a speculum or œsophagoscope various landmarks must be identified on the downward passage after practice this can easily be done so that introduction of the tube into the gullet is carried out with ease and rapidity

Examination with a speculum—The whole of the necessary manœuvres are carried out under the guidance of the eye. The instrument lubricated with liquid paraffin is held in the left hand and is guided and propelled downward by the fingers of the right hand these fingers at the same time protect the patient s lips. The instrument is used to inspect the hypopharynx and the upper end of the œsophagus The tongue is depressed as with a spatula and the operator s left hand is lowered until the speculum is almost horizontal the top of the epiglottis is thus displayed It is essential during this manœuvre that the patient s head should be well raised to straighten the cervical spine

The epiglottis is passed and the speculum with the beak directed laterally is guided into one or other pyriform fossa preferably the right To reach this region it is wise to see and identify the upstanding tip of the cartilage of Wrisberg in the ary-epiglottic fold and to pass outside it. Having entered the right pyriform fossa the beak of the speculum is depressed and is directed slightly to the left while the larynx is at the same time lifted forward by pressure of the instrument against the cricoid cartilage If this manœuvre is carried out

accurately while the speculum is made to slide gently downward—mainly by the action of the thumb and first finger of the right hand—the crico-pharyngeal fold will come into view and will gradually relax

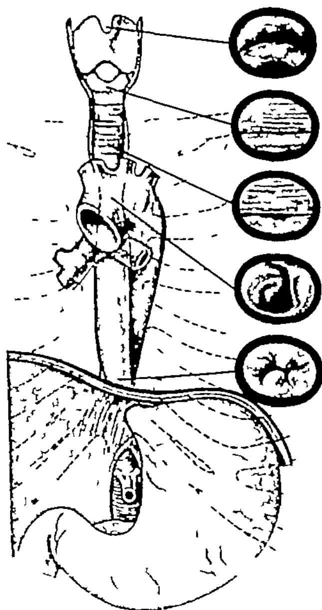


Fig. 722.—Œsophagoscopy appearances at various levels.
(Reproduced by permission from Walter Howarth's British Encyclopædia of Medical Practice Vol. 5 Butterworth & Co.)

to admit the beak of the instrument and thus disclose the lumen of the œsophagus proper which opens as air enters during inspiration

Examination with the œsophagoscope—This is passed in much the same way except that the tube itself is grasped and not its handle It is desirable to reverse the procedure just described and to employ

the right hand for holding and guiding the tube while the left hand protects the lips and controls onward movement.

Once the œsophagus is entered a collection of fluid or froth may be seen The suction apparatus will remove this but swabbing may also be needed or lumps of food may require removal with forceps The curve of the thoracic œsophagus is followed by depressing the patient s head gradually while moving it slightly to the right. In passing through the lower third of the gullet it is necessary to depress the head considerably taking care to have a clear lumen always in view with no blind thrusting forward When the diaphragmatic orifice is reached the tip of the œsophagoscope should point in the direction of the left anterior superior spine of the patient s ilium. The hiatus appears in rosette form and closed in contradistinction to the lumen of the thoracic œsophagus which is lax and widely open during inspiration partially closing during expiration (Fig 722.) A short distance below the level of the diaphragm the œsophagoscope will enter the stomach the mucosa of which is recognized by its darker pink colour and its well marked large rugæ.

Dangers of œsophagoscopy —There has been a considerable number of accidents due to the passage of an œsophagoscope.

Danger is most likely to happen when the instrument is passing down the pyriform fossa before entering the mouth of the œsophagus.

The resistance of the crico-pharyngeal sphincter impedes the forward passage of the tube which may perforate the walls of the hypo-pharynx. This is more liable to occur if the operator is uncertain of his location and directs his instrument against the wall instead of medially in the direction of the œsophageal lumen This mistake is avoided if the ary epiglottic fold of one side is recognized so as to make certain which pyriform fossa is being entered if the tube is slipped down on the right side and if the beak be then directed towards the left danger should not arise

Avoidance of œsophagoscopes with a very narrow lumen and a sharp beak is recommended and if there be doubt the operator is advised to find the mouth of the œsophagus with a flexible bougie

Avoidance of tearing the wall during removal of a sharp foreign body is attained by the indentification of embedded points and by careful disimpaction combined with thorough relaxation of the patient.

CHAPTER XXXII

OPERATIONS ON THE ŒSOPHAGUS

By G GREY TURNER and SIR VICTOR NEGUS

METHODS OF TREATMENT WITH THE ŒSOPHAGOSCOPE

Removal of foreign bodies.—Swallowed objects lodge in the œsophagus because of their size or their shape and character Dentures and coins are examples of the former while among the latter are sharp objects such as bones and pins The usual site of impaction is the crico-pharyngeal fold next in order of frequency is the level of the thoracic inlet in small children If an object passes these points of constriction it is likely to slip through the œsophagus into the stomach but large bodies like tooth plates may be impacted near the crossing of the left bronchus

The commonest objects are halfpennies and the subjects are usually children. Farthings are too small for impaction and pennies too large to be put into the mouth. The coin lies transversely at the mouth of the œsophagus and if recently swallowed, is readily removed by the direct method which should present no difficulty with adequate apparatus and some little practice and experience The removal can be carried out by one skilled in the art without any anæsthetic as the manipulation is little worse than simple depression of the tongue. In nervous or apprehensive subjects general anæsthesia is preferable and this should always be used in cases of long standing impaction or with irregular or sharp-pointed objects In such circumstances complete relaxation of the pharyngeal and œsophageal musculature is essential and can be secured by injecting a relaxant with the anæsthetic.

The patient is placed in the position described (p 1742) with the head raised and extended an œsophagoscopal speculum is passed into the mouth and used like a spatula to depress the tongue In adults who have a full set of front teeth it may be easier to insert the instrument on one or other side of the tongue at the angle of the mouth The beak of the spatula is made to slip behind the larynx care being taken not to injure the latter Secretions are removed by suction or swabbing The upper edge of the coin will in all probability be seen lying transversely and upstanding behind the posterior laryngeal wall It is grasped with serrated forceps care being taken to avoid including any mucosa. The beak of the speculum is moved downwards to touch the coin and the tube and foreign body are then drawn up and removed together

If the coin has been *in situ* for a long period that is to say from four to twelve weeks or more it is better to use toothed forceps with these the grip is taken just beyond the beading When traction

sulphate (gr x) should be tipped on to the back of the tongue every five or six hours and lozenges of phenol (gr ½) should be sucked four-hourly

Complications.—In recent cases little harm may be done if care and skill have been employed in extraction Sometimes however considerable laceration of the œsophageal or pharyngeal walls is caused particularly if blind attempts at removal have been made by one who is inexperienced or not equipped with suitable apparatus The umbrella probang and coin catcher in past days led to many such accidents and should be avoided In extreme cases of trauma a rubber feeding tube may be passed down the œsophagus and left in place for two or three days but this does not of course prevent the passage of saliva over the raw area

PERFORATION OF ŒSOPHAGEAL WALLS

This may be of two varieties the *immediate* or the *gradual* The former is nearly always the result of injury by bougies the œsophagoscope or gastroscope or external violence as in some motor car or aeroplane accident or the sudden perforation of a persistent ulcer or the so-called spontaneous rupture of which the real cause is not yet understood.

The gradual perforations are the result of infection with ulceration or are caused by pressure necrosis from an infected foreign body Immediate perforation may be known to have occurred through a history of the use of instruments or may be suspected from the symptoms following or they may be sudden very severe emergencies as when an ulcer perforates or as in the classical spontaneous rupture.

Perforation of the **cervical œsophagus** is sometimes of the gradual variety but is more often immediate due to foreign bodies or bursting of a peritonsillar abscess One of the first signs is extensive local tenderness with pain on swallowing Later there may be swelling or emphysema The X ray is very helpful in diagnosis An abscess may be deep-seated or may find its way to the surface at the anterior or posterior border of the sterno-mastoid.

Free opening by an incision lateral to the trachea may suffice or it may be necessary to cut down as in the earlier stages of œsophagotomy (Fig 728) The patient lies in the dorsal position with the head somewhat extended and turned to the opposite side.

If the abscess is extensive the anatomical structures may be obscured by œdema and the operation is terminated as soon as the abscess is reached The foreign body may or may not be found The wound should be dusted with sulphanilamide and penicillin and lightly packed with gauze and left widely open. Rarely the inflammatory process causes sloughing of vessels arterial or venous. This considerably increases the difficulties of treatment Ligation of branches or of the great vessels themselves may be required. Septic thrombo-phlebitis is apt to occur and if so the affected portion of vein may be excluded by ligatures and excised

If there is *gradual* perforation through the walls of the **thoracic œsophagus** localized mediastinitis with a para-œsophageal abscess may result and may be recognized by the characteristic radiographic appearances of air outside the œsophagus

When such an abscess does not clear up as a result of treatment by the antibiotics it must be opened by *cervical thoracotomy* or even the transpleural route If the pleura has become infected aspiration or intercostal drainage will be necessary

In many cases of apparently only slight injury there is no localization and the serious complication of acute mediastinitis develops at once. This may declare itself almost immediately after the interference or may be delayed for 12 to 24 hours The symptoms are retrosternal pain extreme difficulty in swallowing high temperature usually ushered in by a rigor and profound toxæmia Physical signs are few *the most prominent are at the root of the neck where the tissues* may crepitate and a painful swelling may develop The condition is often rapidly fatal though in some few cases there is localization with abscess formation Treatment must be as for septicæmia, and the sulphonamide group of drugs and the antibiotics will play the most prominent part If the symptoms do not rapidly improve and there is swelling or even tenderness at the root of the neck *cervical thoracotomy* may be necessary

Technique.—A low collar incision should be made through the deep fascia and the finger insinuated backwards and downwards by the side of the trachea and between it and the carotid sheath When the cellular tissue surrounding the œsophagus is reached gas or thin sanious infected fluid or horribly fœtid pus may escape Soft rubber drains must be inserted in the track of the finger and the wound left open The patient should be nursed with the foot of the bed raised

SPONTANEOUS RUPTURE OF ŒSOPHAGUS*

The main symptoms are severe intrathoracic pain *collapse tendency* to cyanosis increasing difficulty in breathing and emphysema. An abdominal emergency is usually suspected but the signs are not definite and the pain does not yield to morphia. As a rule the condition rapidly deteriorates leading to death with 24 hours

When immediate perforation or rupture is suspected steps must be taken at once to confirm the diagnosis Signs of involvement of the pleura are most suggestive and important either the right or left may be affected Pneumothorax and pleural effusion occur rapidly *Gastric contents may be withdrawn from the pleura by the* exploring syringe X ray examination will be invaluable sometimes a bougie or opaque material can be seen to pass through the perforation into the mediastinum or pleural cavity If the patient's condition allows the œsophagoscope may also be used

* It may follow an attack of vomiting in a healthy subject who is often an alcoholic or may complicate a case of head injury e g a week afterwards

In the acute case when the diagnosis is made immediate thoracotomy is indicated and this is so even in late cases for patients *in extremis* have recovered A wide opening of the pleural cavity is necessary either through an intercostal space or by removal of the seventh or eighth rib to facilitate exposure and manipulation of the injured site The perforation or tear is nearly always in the lower third and the right side of the chest seems to be most commonly involved

The mediastinal pleura must be freely incised or any pre-existing tear enlarged as there is often a considerable effusion into the mediastinal cellular tissue

It is not always easy to identify the site of perforation It is usually just above the diaphragm and on the lateral aspect of the œsophagus but it may be posterior

As a rule the injury takes the form of a longitudinal tear about an inch long or its edges may be ragged or friable or it may be like a perforated ulcer Repair by suture should be attempted Interrupted stitches of catgut or silk should be used but they must be only lightly tied as they easily cut out any loose cellular tissue should be drawn over the area If closure is uncertain or poor the end of a softened tube should be anchored to the area by a loosely tied stitch and brought out of the chest On the first sign of leakage moderate suction should be applied If it is not possible to make a closure or if the œsophagus is very ragged, gastrostomy may be performed in addition to the drain This may either be done at the conclusion of the operation or 48 hours later

In any case the mediastinal pleura should not be sutured and a softened tube or rubber strand should be brought from the site and through the lower chest to the exterior either by the original chest incision or through a separate incision in a posterior intercostal space It should be conducted into a water seal In any case it will usually be wise to pass a moderate sized œsophagus tube or a Ryle s tube by the mouth and to guide it past the repair into the stomach If this has to be done after the chest is closed its position should be checked by the X ray

The chest is closed by suture and the lung gently re-expanded. Of course the resources of chemotherapy and the antibiotics as well as the restorative measures must be exploited to the full.

Complications to be watched for are infection of the opposite pleura, residual abscess or empyema and the development of œsophageal fistula. Although the mortality has been high some remarkable recoveries have been recorded *

ŒSOPHAGOTOMY

In some few cases foreign bodies have been so long impacted that they cannot be removed endoscopically or unsuccessful attempts at removal have so injured the œsophageal wall that it is not safe to

* [illegible] Turner, *Newcastle Medical Journal*, Jan 1945, xxii Barrett *Brit Journ. Surg* 1947 xxxv 216 Schofield, *Brit Med. Journ.*, Feb 26, 1949

leave them *in situ* and open operation is essential In these circumstances œsophagotomy is indicated In the great majority of cases the cervical route will suffice though bodies deeply imbedded in the walls about the middle of the œsophagus may have to be approached by thoracotomy *

Other indications for œsophagotomy may be the treatment of an intractable form of non malignant stricture or the removal of some non malignant tumour which cannot be dealt with endoscopically

Cervical Œsophagotomy

Technique —The œsophagus is opened in the lower part of the left anterior triangle of the neck (Fig 723) It is most important that

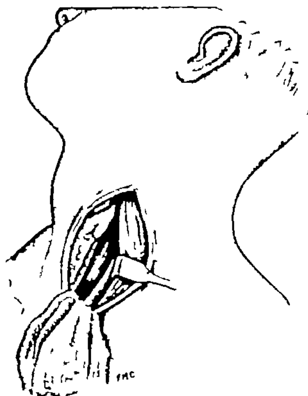


Fig 723 —Œsophagus exposed at root of neck between trachea and carotid sheath.

the shoulders should be raised and the neck well extended with the head turned to the opposite side The incision is then made along the anterior border of the sterno-mastoid from the upper border of the thyroid cartilage to the sterno-clavicular joint The anterior border of the muscle is defined and cleared and is drawn outwards. The incision is deepened and the anterior belly of the omo-hyoid muscle divided The middle and inferior thyroid veins must be divided between ligatures. The carotid sheath should be exposed but must

* Grey Turner *Brit Journ Surg.*, Jan., 1947 xxxiv

not be opened and it is better not to divide the inferior thyroid artery though that step may be necessary in low lying lesions The carotid sheath is gently retracted outwards and backwards and the thyroid gland with the trachea and larynx inwards and forwards In the interval the œsophagus can be reached by blunt dissection Though it inclines towards the left it is largely hidden by the trachea. The œsophageal wall is recognized by the longitudinal muscular fibres but may be more readily identified by passing a large rubber œsophagus tube from the mouth Two guide sutures of catgut should be inserted into the œsophageal wall about the middle of the part exposed when these are gently drawn upon the œsophagus is lifted up towards the surface. The cellular tissue should be carefully protected by gauze soaked or dusted with antiseptic. The œsophagus is opened by a very small vertical incision between the guides and mucus—which will almost certainly be infected—removed with the suction apparatus The incision is then prolonged to the length of an inch or a little more and if the foreign body is not at once found the finger can be introduced and will usually be able to reach the object. The finger is used in the first place so that if necessary the œsophageal wall may be gently pushed away from the intruder A strong reliable pair of forceps may then be introduced and the foreign body grasped If it cannot be easily withdrawn no force should be used and it must be coaxed free of the œsophageal wall which must be disentangled from it with the finger or some blunt flat instrument

After the removal the area is carefully cleansed and the wall of the œsophagus closed with a continuous suture of catgut passed through the mucous membrane and the submucous coats if they can be separately identified This stitch must be hæmostatic and water tight After further cleansing of the œsophageal wall this first stitch is buried by a series of interrupted sutures drawing the muscular layers together These stitches must not be too tight or they will cut through the muscle. It is a good plan to smear a little sulphanilamide over the suture line The guide sutures are now withdrawn and the œsophagus allowed to slip back into its normal position The protecting gauze is removed from the wound A very soft rubber tube or a strand of rubber tissue about the size of a little finger is brought from the depths of the wound by the most direct route to the surface. No deep sutures are inserted but the platysma and skin are carefully drawn together leaving ample room for the drain. If the œsophageal wall is inflamed and friable no attempt should be made to close it by suture In these circumstances the whole wound should be dusted with sulphanilamide and penicillin left open and lightly packed with gauze A voluminous dressing is applied to act as a splint for the neck

After treatment.—The patient must be nursed lying flat or if there is evidence of severe infection with the foot end of the bed raised. Only very small quantities of liquid are allowed by the mouth for the first day or two nutrition being largely supplied by the

intravenous route Any gauze pack which has been used must be left untouched for 48 hours and then only gradually removed. Rubber drains should remain for a week. For possible complications see p 1766

INTRA THORACIC ŒSOPHAGOTOMY

When the foreign body is firmly impacted at or below the level of the arch of the aorta and cannot be extracted endoscopically it is unlikely that it will be possible to remove it safely from even a low cervical œsophagotomy and extraction is now nearly always done by the trans-thoracic route In such circumstances the thoracic œsophagus must be attacked Unless there is some very special contra indication thoracotomy will nearly always be the method authorized Patients for whom these operations are required are usually in very poor condition and may have some difficulty in swallowing so that preliminary passage of a small indwelling stomach tube through the nose is generally wise though not always essential. The operation on the œsophagus should not be contemplated until full benefit has been obtained from careful feeding and pre-operative care including the use of penicillin.

Technique.—The general technique of thoracotomy must be followed (*see* p 852 Vol. I) The question of the side from which the approach should be made can be generally answered by stating that the lower third of the œsophagus is most accessible from the left while for the middle third and lower part of the upper third the right-sided approach is best Once the chest cavity has been freely opened the approach to the œsophagus and its exposure is the same as when excision is contemplated (p 1782) Infection is guarded against by the exercise of care at the time of removal and by the resources of chemotherapy

The œsophagus should not be mobilized more than is essential for exposure as this would open up the cellular tissue to infection. A direct incision through the parietal pleura will quite likely demonstrate that structure adherent to the œsophagus If the latter tends to slip away a couple of guide sutures may be inserted to steady it and to draw it nearer to the surface

A foreign body which has resisted endoscopic removal will probably be so tightly impacted or imbedded in the œsophageal wall that it will be necessary to incise directly over the site for its removal. The smaller the opening in the œsophagus the better provided always that the foreign body can be extracted without laceration of its edges

The incision must be drawn together by interrupted sutures only lightly tied lest they cut out or lead to necrosis

When the œsophageal wall is very friable the parietal pleura may be tacked to it by a stitch or two and the sutures of apposition passed through the pleura as well as the œsophagus

If there is any loose cellular tissue in the neighbourhood it is wise to draw it over the suture line It is wise to leave in a softened tube or a strand of rubber sheeting to establish a track to the surface by the

most direct route The alternative is to be watchful as to the development of an infective effusion or empyema and this may necessitate repeated X ray examinations

Complications.—In some of these cases there is a fistula between the œsophagus and some part of the bronchial tree this may heal after removal of the foreign body unless a complicating fibrous stricture develops at the site of impaction If the latter is anticipated by the symptoms or confirmed the use of mercury weighted bougies passed at the end of about a fortnight may check its further progress A fully developed stenosis must be treated as described later (*see* p 1762)

There may be many difficulties in this operation but the essentials are a good exposure good hæmostasis and adequate illumination It should be a deliberate orderly proceeding conducted without haste and modified according to the conditions found and the difficulties encountered Feeding difficulties may be met by the use of an indwelling œsophageal tube passed through the nose.

It must be reiterated that if swallowed foreign bodies are dealt with promptly by experts in direct endoscopy working in properly equipped clinics none should require removal by the external route. The only exceptions will be those which have perforated the œsophageal walls or become imbedded before arrival at a proper clinic.

ABNORMALITIES

In most of the cases the abnormality turns out to be some form of atresia with œsophago-tracheal or bronchial fistula. The condition is expected about once in every 3 000 infants born alive though it may prove to be more frequent since so much attention has been drawn to the recognition of the condition. In spite of current supposition it is usually the only abnormality present and when it can be successfully treated by prompt operation the infants thrive and develop like normal individuals * The upper blind and dilated end terminates usually about the level of the azygos arch and the lower narrow segment is attached to the back of the trachea just above the bifurcation or to the left bronchus where there is usually a small slit like fistula between the two tubes This is the condition found in about 80 per cent of the victims In the remainder there may be no fistula or the ends are widely separated or the lower segment is very much attenuated. Aspiration into the respiratory tract occurs as the result of an overflow of secretions or feeds from the upper dilated end When gastrostomy has been carried out there is also regurgitation from the lower end In either case pneumonia is the invariable result and is by far the commonest cause of death in the untreated case

During the last few years direct attack on the site of the abnormality has been carried out with increasing frequency and with restoration of continuity of the œsophagus Though the mortality has been high many infants have now recovered from the intervention and have gone

* R H Franklin, *Proc Roy Soc of Med.* (Clinical Section), Feb., 1949, xl

should be restarted In most cases healing has occurred. In a few cases stricture at the site of anastomosis has developed during convalescence but has usually been overcome by the proper use of bougies.

The operative mortality is still high perhaps about 50 per cent., but it is improving with earlier diagnosis the help of penicillin and intensive after-care

1 Congenital

a **Complete Imperforation.**—This condition is now usually discovered within 24 hours of birth and unless efficiently treated during the first few days of life can only result in death of the infant though this may be deferred for many days The actual cause of death is usually not entirely from starvation but from inflammatory lung changes the result of aspiration into the bronchial tree If the child survives a direct attack may be made on the site of deformity using the trans-thoracic approach

b **A partial web**—If expert assistance is available the œsophagoscope should be used in the hope that some small channel may be found which can be dilated or intubated Chevalier Jackson has divided short webs with success When discovered in later life, they are stretched or broken down or divided Such webs usually occur at the level of the crico-pharyngeal fold but occasionally at the diaphragmatic hiatus.

c **Congenital strictures** may only produce very mild symptoms in infancy or childhood but tend to get worse later in life. Their treatment is that of simple stenosis (*see* p 1762)

d **Shortening of the œsophagus.**—This condition has been brought into prominence in recent years through the writings of Brown Kelly Leonard Finlay Sir Thomas Dunhill and others. The condition accounts for many cases of dysphagia in which the cause was previously undiagnosed. In well marked cases the œsophagus ends several centimetres above the level of the diaphragmatic hiatus, usually at about the seventh thoracic vertebra. In some not only does the lowest segment fail to elongate but its lumen may also be deficient and fail to open out as growth proceeds. Furthermore there may be some defect in the normal epithelial lining so that the walls are open to spread of infection from the lumen with resulting infiltration and fibrosis

The deficiency of the œsophagus in length is compensated by elongation of the stomach which reaches above the diaphragm thus being sub-divided into thoracic and abdominal segments, communicating by a wide opening through the diaphragm (Plate V)

Symptoms—Three types of symptom may arise and each must receive appropriate treatment The three types may appear singly or in combination



PLATE X.—Congenital shortening of œsophagus.

The radiograph shows a moderately dilated œsophagus, with a stricture where the shortened œsophagus joins an intrathoracic stomach. The latter is considerably dilated and communicates with the abdominal portion of the stomach through a dilated diaphragmatic opening. The patient was a lady aged sixty, who had suffered from flatulent indigestion all her life. The cause of her symptoms was not discovered until severe gastric pain and vomiting necessitated a radiographic examination.

(Reproduced by permission from St. Clair Thomson and Negus: Diseases of the Nose and Throat, Cassell.)



PLATE VI – Diverticulum of thoracic œsophagus.
The patient, a woman of fifty two suffered from intermittent difficulty in swallowing for five years.

(Reproduced, by permission, from The British Encyclopædia of Medical Practice, Butterworth)

In the first *dysphagia* is the leading symptom This is the result of a narrowing at the junction of the œsophagus and stomach either from developmental defect alone or from secondary fibrosis The first line of treatment is the same as that advised for non malignant stenosis and it will have to be repeated according to the necessities of the case In intractable cases gastrostomy is required with subsequent retrograde dilatation as described on page 1765 Eventually gastrostomy feeding will no longer be required but the opening into the stomach should still be maintained by retaining the rubber catheter or a plug in the stomach until normal swallowing has been restored.

The second type of symptom is *regurgitation of food* due to stagnation in the œsophagus or the result of reflux of acid secretions from the thoracic stomach causing ulceration When the latter occurs there may be severe pain on swallowing either retro-sternal or referred along the left lower ribs For the most part the treatment here is medical and not operative Barium sulphate or other alkaline powders are given frequently and the patient is advised to sleep sitting up so that gravity may help to prevent regurgitation

The third complaint is a *feeling of fullness* in the lower thorax or a sensation of intra thoracic pressure and there may be attacks simulating angina These symptoms are due to distension of the thoracic stomach with food or gas and may be relieved by dividing the left phrenic nerve in the neck which presumably does away with any part that diaphragmatic contraction plays in their causation

Operation.—If the measures for relief are not successful operation may be required. From an abdominal approach it may be possible to mobilize the stomach as it passes through the diaphragm and to bring the thoracic segment down into the abdomen and to fix it to the diaphragm by suture Another method is to enlarge the diaphragmatic opening so that the cone of stomach is not constricted Or the diaphragm may be mobilized and fixed by suture above the cone of stomach If there is extreme dilation with kinking anastomosis may be established between the abdominal and thoracic portions of the stomach This operation is in all respects similar to œsophago-gastrostomy but will usually have to be conducted by the trans thoracic route

These plans may be considered unlikely to be effective or they may fail or there may be recurrence In these eventualities trans-thoracic resection of the lower end of œsophagus with the displaced cardiac part of the stomach may be carried out the œsophagus being anastomosed by direct suture to the open extremity of the divided stomach * The technique is described at pp 1787 1788

2 Acquired Abnormalities

Pharyngeal diverticula cause symptoms of œsophageal obstruction and are described at p 1686 *Pouches* in the lower œsophagus also

* Dickson Wright *Proc R Soc of Med* March 12, 1948

occur (Plate VI) they may be caused either by pulsion or traction and may be present without producing symptoms or are associated with some degree of œsophageal obstruction Investigation sometimes shows some narrowing of the gullet at the site of origin of the pouch or the symptoms may result from the intermittent over filling of the pouch as in the pharyngeal variety Probably some such pouches are congenital but have not caused symptoms until the development of malignant disease in the œsophagus beyond. This combination must always be borne in mind Any concomitant stricture of the œsophagus can be treated as in other examples of simple stenosis. Pouches which give trouble by overfilling can cause serious inanition and require treatment Gastrostomy ensures against starvation but must only be regarded as a temporary measure nevertheless it should often precede direct surgical intervention on the pouch

Anastomosis to stomach.—Very large pouches arising from the lower œsophagus have been anastomosed to the cardiac end of the stomach with good results This operation may be carried out by the trans-thoracic route on the left side. The cupola of the diaphragm is incised and the cardiac end of the stomach drawn up into the chest when the anastomosis can be made by direct suture between the pouch and the stomach In this operation it is an advantage if the œsophageal pouch can be emptied by tube or through the œsophagoscope some few days preliminary to operation

The same operation may be done in two stages The first consists of transpleural exposure of the œsophagus with the pouch and crushing the phrenic nerve as it passes down the lateral wall of the pericardium The diaphragm is incised and a cone of the fundus of the stomach is drawn into the chest cavity and its base sutured to the edges of the diaphragmatic incision The œsophageal pouch and the cone of stomach are sutured together but without opening the mucous membrane and the chest is closed. Three or four weeks later the chest is re-opened and the anastomosis completed. The anastomosis is made by direct suture and the opening must be large enough to admit two fingers

When the fundus of a large diverticulum extends right down to the bottom of the pleural cavity it may be possible to carry out the anastomosis from the abdomen Whether it will suffice to enlarge the œsophageal hiatus so that the fundus of the diverticulum can be drawn down and approximated to the stomach or whether an independent incision of the diaphragm will be necessary depends on circumstances Every case must be carefully and independently studied

Removal of pouch.—When the diverticulum arises from about the middle of the œsophagus or higher it will probably not be feasible to make an anastomosis and other modes of relief must be considered Pouches of moderate size may cause very marked symptoms and in

such circumstances the question of their removal properly arises It must be realized that pouches unassociated with malignant disease are not lethal and can be palliated indefinitely sometimes by dilatation of the œsophagus at their site of origin and certainly by gastrostomy If the surgeon decides to intervene the patient should be got into good general condition and usually preliminary gastrostomy will be necessary The pouch should be emptied of decomposing and probably septic contents before the approach Exposure should be by the trans thoracic route which gives more latitude (p 852 Vol I) The empty pouch may be difficult to identify and during the operation all should be in readiness for the passage by the mouth of the illuminated œsophagoscope The pouch having been identified and thoroughly mobilized right up to the point of its attachment to the œsophagus may be excised invaginated into the œsophagus turned upside down and fixed in that position or its extremity anastomosed to the œsophagus lower down. Which of these plans is to be adopted will depend as much on the experience of the operator as on the local conditions If excision is selected the surgeon must take care not to constrict the œsophagus at the site of removal After proper exposure the technical steps of removal are the same as those for pharyngeal pouches (p 1687)

INFLAMMATORY DISEASES

Chronic Hypopharyngitis

This is a condition of considerable surgical importance owing to its relationship to post-cricoid carcinoma. It is an inflammation of a particularly chronic type affecting the mouth of the œsophagus and in particular the pharyngeal aspect of the crico-pharyngeal fold. Descriptions of the disease were given some years ago by Paterson and Brown Kelly The inflammation is of an atrophic type with glazing superficial ulceration and subsequent healing with scar formation Contraction leads to narrowing of the mouth of the gullet. A pulsion diverticulum may form above and may be excised under the mistaken supposition that it is the cause of the symptoms

Treatment.—Treatment consists of periodical dilatation with flexible bougies or a bag passed under direct vision If webs have formed they must first be ruptured by forceps or by the wedge-like effect of an œsophageal speculum gently insinuated Large doses of iron should be given if anæmia is present Many cases of carcinoma have been known to arise as a sequela of this chronic inflammatory process and careful watch must therefore be kept in order to institute treatment of such a growth in its early stages It is considered justifiable to treat severe cases with suspicion of early carcinoma by excision of the region and plastic reconstruction even before definite malignant disease can be detected Gastrostomy may be required as a preliminary

Stenosis

Cicatricial stenosis may follow the swallowing of corrosives or occasionally acute inflammation or may arise from a variety of rarer causes Amongst these are long-standing impaction of a foreign body peptic ulceration and chronic inflammation at the crico-pharyngea fold A similar condition occurs in some cases of short œsophagus.

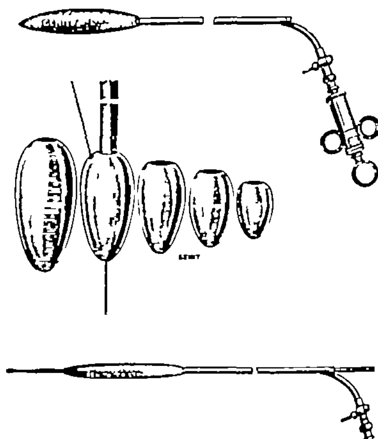


Fig 724 —(Top) Tucker's hydrostatic bag dilated with water (Bottom) The bag collapsed, with our modification of a hollow stem sliding on a guide to facilitate its introduction. The middle figure shows thread-guided olivary bougies carried on a flexible staff

In all cases dilatation through the mouth should first be attempted and with skill and perseverance will usually be successful.

Dilatation can be carried out (*a*) from above by passage of bougies or by distension with a dilatable bag under direct vision through an œsophagoscope (*b*) by dilation with bougies or a bag under fluoroscopic guidance (Mosher) (*c*) by gradual dilatation with bougies passed blindly either by the medical practitioner or the patient (*d*) by the thread-guided method (Plummer) (*e*) by retrograde dilatation (Gabriel Tucker) (*f*) by indwelling tube or (*g*) by indwelling dilator

(a) **Bougies.**—The passing of bougies under the guidance of direct vision is easy for those practised in endoscopy if a wide and well illuminated œsophagoscope be used The stricture is exposed and secretions are removed by suction and swabbing The lumen may be to one side but gentle search will generally secure entrance for the tip of a flexible dilator dipped in liquid paraffin Graduated sizes are introduced in succession until the lumen is brought up to a calibre sufficient to allow food to pass freely Other strictures may be found below the uppermost ones and they too will require dilatation

Once the lumen of the stenosis has been negotiated with a bougie a bag of the Tucker pattern may be used carried on a flexible hollow stem attached to a thin metal tube (Fig 724) The flexibility of the instrument allows it to pass easily through a narrow stricture and it can then be dilated with water introduced by a syringe so as to exert a stretching effect The pressure is regulated by the hand The dilatation may have to be repeated after a month and subsequently at longer intervals until swallowing powers are satisfactory Treatment over two years or more may be required particularly for multiple strictures

(b) Mosher recommended **dilatation under fluoroscopic guidance**

(c) **Blind self passage bougies.**—These have fallen into general disfavour because of reports of numerous accidents though these have occurred mainly in cases of carcinoma. One of us has however used blind bouginage carried out by the patient and with notable success where other measures have failed.* Gentleness and care are required and the patient s sensation of pain must be used to give indication of danger The method is simple and often effective but is reserved for selected cases to be treated with due precaution. The main point is to teach the patient to swallow the bougie when it is caught in the narrowing it may be advanced by very gentle manipulation at first by the surgeon and later when confidence is established by the patient

The type used is the gum elastic bougie of French manufacture softened by immersion in hot water When the stenosis has been reasonably dilated it may sometimes be kept patent by using Hurst s mercury filled bougies with which there is little danger During the treatment the patient should persevere with semi-solid and as soon as possible with solid food as each bolus acts as a dilator

(d) **Thread guides.**—The thread-guided method is of particular use where there is great difficulty in getting any instrument through the stricture It is sometimes effective where bouginage under direct vision or other methods has failed. The patient must swallow a length of silk thread (button hole twist No 5) and for this purpose is given four yards wound on a small spool of cardboard The end is placed in the mouth with a sufficient length of slack to give play without tangling By swallowing efforts possibly assisted by drinking the thread usually manages to find a way through the stenosis but this

* Grey Turner Brit J Surg 1939 xvi, No 103, 555 1940, xx iii, No. 110, 275 and 1943 x, No. 120 344

occurs slowly at the rate of about a foot an hour the patient be warned against biting the thread. When the part in the : has disappeared down the gullet a further length of slack is pai and so on until between three or four yards have been swal The thread will then be anchored firmly in the small intestine ar be drawn taut A small olivary bougie mounted on a whalebon and with a smooth hole bored through its bulbous end is threac to the line and guided into the œsophagus (Figs 724 and 725) H the line taut in one hand and the flexible staff in the other the su gently guides the bougie to the stricture in the hope that it may be enough to slip through All that the thread can do is to guid bougie to the site and face of the stricture and only the ge manipulations must be used in negotiating it through the nar part Subsequently bougies are passed at int of 24 hours or more

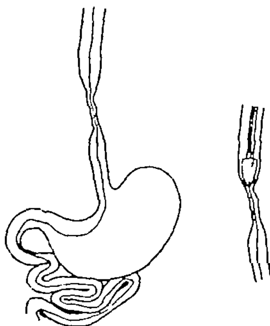


Fig 725.—A swallowed silk thread used as a guide for the passage of an œsophageal bougie The figure on the right shows an olivary bougie mounted on the thread and thereby guided to the mouth of the stricture (Vinson s method)

(*c*) **Retrograde dilatatior ker s method)** — This tecl is only possible where g stomy has been performe swallowed thread is fish from the stomach and b flexible bougie or a grac chain of glass or metal is drawn up through th rowing and out by the r A thread must be allow remain *in situ* so tha dilatation can be repeatec the stenosis is overcome happy state may not be at for several weeks Tucke a long tapered flexible r bougie moulded on a thread graduated size made An alternative is t of beads or bobbins, st with a small size and gra increasing When the st has in this way become negotiable treatment can be con by bougies passed from the mouth.

In the few cases in which these methods are not successful methods may be required. These are —(1) division by diatl current through the œsophagoscope (2) retrograde dilatation th a gastrotome (Fig 726) (3) direct exposure of the strictured ar the purpose of (*a*) plastic enlargement (*b*) excision with anastor

(*b*) formation of an ante-thoracic œsophagus or (*c*) by bridging the gap between a cervical fistula and a gastrostomy with a rubber tube

(*f*) **Indwelling tube** —In certain cases a tube of rubber or plastic material is passed through the stricture and left in position for dilatation of a stricture or to prevent contraction after the swallowing of corrosives The tube may pass through the nose or through an opening in the neck directly into the cervical œsophagus according to the method described by Truls Leegaard

(*g*) **Indwelling dilator** —We have used with success in some cases of resistant stricture a bobbin made either of metal or plastic material with an elongated flexible tip perforated to allow fluids to pass. The dilator is drawn down into the stricture by means of a thread emerging from a gastrostomy opening and is gradually pulled through in the course of four or five days by the gentle traction of an elastic band.

Division by the diathermy current.—In practice this method has proved dangerous and has been followed by development of fistulæ and should therefore never be employed

Dilatation from below —It is not always possible to carry out Tucker s method and retrograde dilatation with bougies introduced from below may have to be employed after gastrotomy The stomach is exposed after laparotomy and its cavity opened If the incision is placed about the middle of the body of the viscus it is often very difficult or almost impossible to guide the bougie into the œsophagus but if the opening is just below the cardia the bougie slips in without trouble (Fig 726) Some strictures which prove completely impermeable from above can be readily dilated in this way The size of bougie which can just be passed through readily should be advanced until it appears in the mouth A rubber tube is then slipped well over its point and tied in position and the bougie is withdrawn from the stomach carrying the rubber tube which is disengaged from the bougie and left in the strictured area. Patients resent the tube and may either attempt to pull it out or displace it by retching For this reason one end should be attached to the stomach wall by a suture of chromicized catgut and the other should project some distance from one of the nostrils The incision in the stomach is carefully closed by suture In from two to four days the fixation stitch will have loosened and the rubber tube may be withdrawn from the mouth and treatment by oral bougies continued. Cases in which the stricture appeared to be impermeable and proved quite unmanageable have been successfully dealt with by this means *

Plastic enlargement.—The plastic measures for stricture of the œsophagus follow the same plan as the operation of pyloroplasty This principle has several times been used in dealing with stenosis at the

* Grey Turner *Brit Journ. Surg* 1943, xviii, 110.

cardiac end of the œsophagus Heller's operation being employed it is described on p 1800 It is also occasionally applicable to the cervical and more rarely thoracic œsophagus *

Excision—Excision of a strictured area can only be feasible when such an area is of very limited extent as the longitudinal tension of the œsophagus does not admit of its ends being brought together to bridge a wide gap

Short circuiting—The principle of short-circuiting may be used with an impermeable stricture or an obliteration at the lower end of

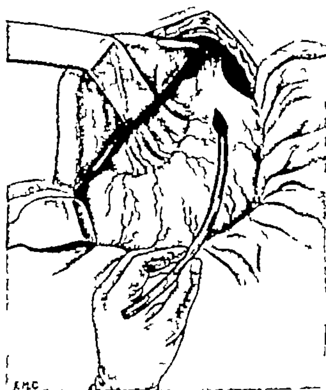


Fig 726—Retrograde dilatation through incision near cardia.

the gullet (œsophago-gastrostomy p 1801) The diaphragm may be incised and the fundus of the stomach displaced into the chest. The œsophagus is then united either side to side or after division, end to side to an opening made in the cone of the stomach. This plan has recently met with success † though there must be very few cases in which it is necessary for non malignant conditions. The other application of this principle is in the formation of an extra thoracic œsophagus or gastrostomy

* Grey Turner *Brit Med Journ* 1940, xxviii, 110
† R C Brock, *Brit Journ Surg* 1942, xxx, 118

Construction of Extra Thoracic Œsophagus

The formation of such a gullet is a problem which seems to have been first tackled by Bircher in 1894 but it was not until 1907 that Roux of Lausanne was able to report a completely successful case.* In that instance the new œsophagus was made of an isolated loop of small intestine which was carried up in a subcutaneous tunnel in front of the thorax The intestine was united at the lower end to the stomach and at the upper end to the cervical œsophagus Since that time great ingenuity has been displayed on the problem and many different methods have been devised and tried with very many failures but

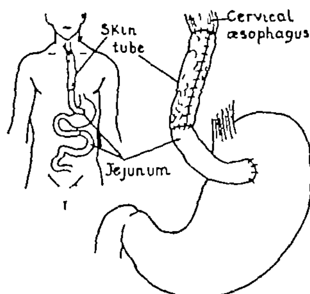


Fig 727 —Jejuno-dermato-œsophagoplasty of Lexer (redrawn from Alton Ochsner)

nevertheless an encouraging degree of success. The technique devised by the Russian surgeon Yudin † aroused renewed interest in this plan but though successes have been reported ‡ there have been many complications and failures The most generally successful plan has been that in which the greater part of the new gullet is made from the skin of the front of the chest and the lower part from an isolated loop of upper small intestine. The upper end of the skin tube is united to the lower end of the cervical œsophagus or a cervical œsophageal fistula by a plastic operation This is the jejuno-dermato-œsophagoplasty of Lexer and is the method which will be shortly described (Fig 727)

A new ante-thoracic gullet can only be constructed by a series of rather complicated operations extending over some months and associated with a not inconsiderable risk and probably many disappointments For these reasons the plan should never be attempted

* Sem méd., 1907 xxvii, 37
† Surg Gyn. Obst 1944 78 [illegible]
‡ Thompson, Proc Roy Soc of Med 1 b 1945.

for non malignant conditions until every other method of treatment aimed at the restoration of the normal channel has been perseveringly tried. It ought to be stated that many attempts have also been made to repair or reconstruct a portion of the œsophagus in its normal situation Most of these have been carried out on the cervical œsophagus where skin flaps have been used with considerable success (p 1775 and Fig 789) The same method has been employed in the posterior mediastinum for the thoracic œsophagus and at least once with success (Lilienthal) Others have endeavoured to reconstruct

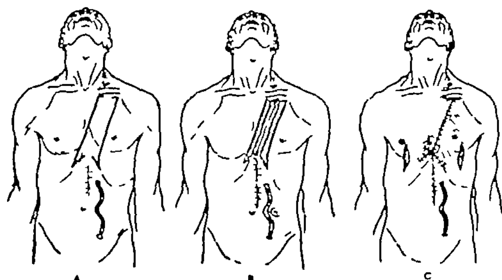


Fig 788 —Œsophagoplasty

A Œsophagoplasty by the method shown in Fig. 787 The thoracic œsophagus has been removed, or divided, and there is cervico-œsophageal fistula just above the clavicle and gastrostomy. The incisions for making the skin tube are indicated. B, The flaps have been dissected up rolled over and sutured together to form the skin tube C, The latter has been covered by undercutting the skin margins, and suturing the edges in front of the dermal tube. To facilitate approximation, lateral tension incisions have been made at either side of the suture line near the costal margin.

the lower part of the œsophagus within the thorax either with a loop of isolated bowel or with a new mucous-lined tube made from the greater curvature of the stomach (Ogilvie) *

The different methods based on a study of 24 cases will be found described in a paper by Ochsner and Ownes.†

Although the method of the ante thoracic œsophagus has been largely superseded by intra thoracic reconstruction especially after excision for malignant disease it has sometimes proved a useful plan and in certain circumstances may be chosen The method is sometimes regarded as within the domain of the plastic surgeon but most of the cases have been in the hands of general surgeons.

Jejuno-dermato-œsophagoplasty technique —The series of operations required in œsophagoplasty should never be undertaken until the patient is in the best possible state of nutrition which can be

* Brit. J. Surg. 1933, 10

† A. ... œsophagoplasty for impermeable stricture of the Œsophagus, Ann. Surg. Dec. 1934, c, 1055.

secured A preliminary gastrostomy or jejunostomy will always be necessary Some surgeons advise that when a new gullet is in contemplation the gastrostomy should be made with a tube of stomach wall (Janeway or Beck Jianu) or with a piece of isolated jejunum (Tavel) so that it may afterwards be connected directly to an ante thoracic skin tube The problem varies a good deal depending upon

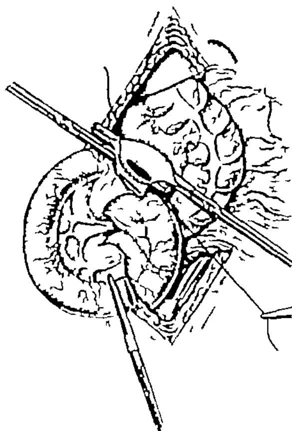


Fig 729 —Œsophagoplasty Loop of jejunum isolated and in process of suture to posterior surface of stomach.

whether or not a cervical œsophageal fistula already exists When the thoracic œsophagus has been removed (Grey Turner Fischer Kidd) the lower end of the cervical œsophagus will open on to the skin just above or below the clavicle (Fig 728 A)

When the whole œsophagus is intact as in cases of impermeable fibrous stricture and a functioning gastrostomy has already been made the operation is best divided into four principal stages

1 The formation of a cervical œsophageal fistula. (Fig 728 A)
2 The making of an ante-thoracic skin tube (Fig 728 A B C)
3 The construction of the lower portion of the new gullet with an isolated loop of jejunum connecting the skin tube with the stomach. (Figs 729–731)

4 The union of the upper end of the ante thoracic skin tube to the cervical fistula (Fig 727)

The illustrations show sufficiently clearly the various steps of the operation. Secondary fistulæ at the points of union of the tubes often occur and in most cases supplementary operations are required for their repair

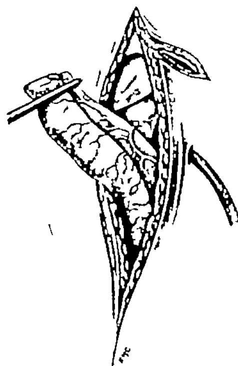


Fig 730.—Œsophagoplasty The loop of isolated intestine prepared for approximation to the lower end of the skin tube.



Fig. 731 —Œsophagoplasty The jejunal portion of the œsophagus being united by suture to the lower end of the skin tube.

Modifications of the technique are being introduced from time to time. To keep abreast of these developments it is necessary to study the recent literature which is becoming voluminous.

One of the most recent plans was devised by Lazar of Budapest to lessen the risk of the formation of fistula.* He isolates a length of upper jejunum and restores continuity by end to-end anastomosis. The upper end of the isolated portion is united to the lower end of the previously made skin tube the distal extremity is completely closed. The lumen of the dermato-jejunum segment is cleansed daily by sulphaguanidine irrigations. Two weeks later when the union is sound the blind lower extremity of the piece of jejunum is opened up and united to the stomach. In about three weeks time and as a last stage the lower end of the cervical œsophagus is united to the upper

* Journ. Int. Chirurgie, XI No. 2, 1951

end of the skin tube. In nine cases there was no mortality Healing was complete and normal swallowing restored after a stay of from 60 to 70 days in hospital

Results —The published results do not always give a correct indication of the difficulties and trials of an operation of this sort Making due allowances it is probably correct to assume that the mortality has been considerable and that probably not more than

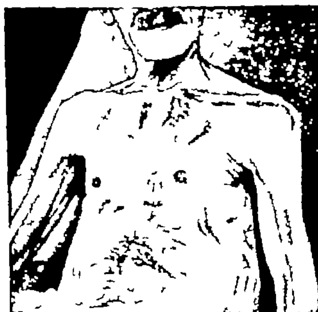


Fig 782 —Œsophagoplasty completed. Patient with all wounds healed and function established.

The photograph was taken on the 206th day after excision of the thoracic œsophagus for malignant disease. The patient lived in comfort for 19 months, death then occurring from acute nephritis.

50 per cent of the cases in which the operation has been begun have been carried to a successful conclusion. But with careful selection of cases multiple stage operations and intelligent and careful technique there is no reason why the results should not be very much better in the future There are patients with ante-thoracic reconstructions surviving in comfort with good functional capacity several years after the operation Mr Sampson s first case * remains well 22 years after operation (personal communication) Grey Turner† carried out this method of reconstruction in a man in whom the œsophagus was excised for malignant disease the patient surviving for 19 months with entirely satisfactory swallowing capacity (Fig 782.) In a similar case the patient was alive and at work six years afterwards.

* *Brit Journ. Surg* 1933, XX, No. 78.
† *Lancet*, Dec. 9 1933, No. 1315.

OPERATIONS FOR SIMPLE TUMOURS

Papillomata and fibromata may be pedunculated and project into the lumen of the œsophagus while myomata or lipomata arise in the substance of the wall and cause more or less obstruction Congenital cysts have also been found in the œsophageal wall or involving *the wall from outside*

The papillomata and possibly some of the other tumours invading the œsophageal lumen may be removed endoscopically with or without the aid of diathermy though it must be observed that the latter method has proved dangerous unless employed with extreme care and in several sittings

The larger simple tumours causing obstruction should be removed by enucleation or excision of a segment of œsophagus after exposure by the trans-thoracic route while others may be palliated, by partial endoscopic removal or by gastrostomy

MEASURES FOR THE RELIEF OF CARCINOMA

When malignant disease attacks the œsophagus it nearly always takes the form of carcinoma The pathological features of invasion and spread are not in any way peculiar to the site but follow the usual course of carcinoma in other parts of the alimentary canal. Though any part of the gullet may be invaded the usual sites are the upper or lower ends or the middle of the tube. The commonest site is just below the bifurcation of the trachea. The lymphatic drainage is free and it must be remembered that the nodes above the clavicle and below the diaphragm may be invaded and especially the latter which are found high along the lesser curvature and are sometimes known as the supra gastric nodes. While it is probably true that about one-third of the cases display early dissemination to the lymphatic nodes the liver and more distant parts in the remaining two-thirds slow steady invasion of the surrounding structures with death from inanition sepsis or lung complications are the main features. Unfortunately when patients present themselves for surgical advice the growth has usually been in existence for a comparatively long time Even when dysphagia first declares itself the growth has often already spread beyond the walls of the œsophagus In the whole of its course the œsophagus is in close contact with *important* structures that may be involved by direct spread but it is often difficult to determine clinically the degree of extension present. There is the further difficulty that the œsophagus throughout the greater part of its course is anatomically secluded and difficult of access.

Short of such evidence as the presence of enlarged nodes in the neck demonstrable secondary deposits in the liver or gross *involvement* of the lung or pleura it is often difficult to estimate accurately the local spread of the growth. Even when the history is short and the local condition appears favourable as demonstrated by X ray œsophagoscopic and bronchoscopic examination the growth on exploration, may be found to have spread to the surrounding parts to

such an extent that it cannot be excised This has been the experience of all pioneer workers in this field Fortunately the converse is equally true for many growths are found to be strictly localized to the oesophageal wall and quite capable of removal

Although X ray therapy and radium are both of some value as palliative measures there is scarcely any proof of their being curative whereas many cases treated by operation have remained free from recurrence for several years In the present state of our knowledge radical removal should always be considered and undertaken if the surgeon has had adequate training In order to give operative measures the best chance of success it is essential to carry out early and complete diagnostic investigation in every case where there is suspicion of new growth.

METHODS OF TREATMENT

Curative.—(1) Removal by the operation of œsophagectomy (*a*) In the cervical region (*b*) at the lower end of the œsophagus (*c*) in the thoracic region. For (*b*) and (*c*) the trans pleural route is now almost universally authorized In each group restoration of the swallowing capacity is either carried out at the primary operation or at a further intervention.

Palliative.—(1) Repeated dilatation (*a*) Under direct vision (*b*) by thread-guided method (*c*) rarely by blind bougmage. (2) In tubation. (3) Diathermic coagulation. (4) Irradiation (*a*) Super ficial application of radium (*b*) interstitial irradiation (*c*) teleradia tion and deep therapy (5) Short circuiting (*a*) by intra thoracic anastomosis of œsophagus above growth to stomach or intestine (*b*) by construction of extra thoracic œsophagus or by rubber tube (*c*) by gastrostomy

Œsophagectomy General observations.—All the methods of œso-phagectomy must be governed by the knowledge that it is never possible to make an end to-end anastomosis of the œsophagus if the malignant growth has been excised sufficiently widely Because of the tendency of the growths to spread up and down beneath the mucous membrane it is essential to remove a considerable length of œsophagus above and below the obvious growth and this further complicates the problem. The selection of cases always merits serious consideration. In Great Britain the disease most commonly attacks male subjects over the age of 50 but it may occur at any age though rarely in the thirties or over 70 Many of the patients are the victims of cardio-vascular disease or of emphysema often with chronic pul monary infection furthermore the renal function is frequently poor Such subjects are bad risks for any type of surgical interference much more the very serious type of operation under consideration None the less direct surgical attack may be considered when the patients are young for their years and well preserved when there is no evidence of distant dissemination and when the improvement after adequate

THE TECHNIQUE OF ŒSOPHAGECTOMY

This must be correlated with the anatomical position of the growth Three regions have to be regarded as separate problems (a) the cervical (b) the thoracic and (c) the lower end

The general plan in these various situations is as follows —

The **cervical region** is approached entirely from the neck and restoration is carried out at the site

The **thoracic region** is dealt with by thoracotomy and by free excision of a considerable section of the œsophagus

When the growth is above the arch of the aorta it may be necessary to complete the excision by an approach through a separate incision in the root of the neck.

In either case restoration is made (a) by bringing the stomach up into the thorax through incision of the diaphragm and making direct anastomosis between the divided end of the upper segment of the œsophagus and the summit of the displaced stomach even if this has to be done by carrying the stomach above the clavicle and making the anastomosis at that point or (b) by using a length of upper jejunum carried into the chest either as a loop or a free end or (c) by formation of an ante thoracic gullet for that purpose using either the mobilized stomach or small intestine and skin tube (jejuno-dermato-œsophago-plasty) The **lower end** is excised either entirely through a low thoracotomy with free incision of the diaphragm thus opening the abdominal cavity from above (thoraco-laparotomy) or alternatively by first opening the abdomen for exploration of the cardiac region and the liver and if there are no secondary deposits carrying the abdominal incision through the costal margin into the chest with the division of the diaphragm (laparo-thoracotomy) In either case restoration is carried out as for mid thoracic growths It is a great advantage if the operation can be completed without having to alter the position of the patient If change of plan is necessary this should be carried out gently and without haste and a few minutes rest should be allowed thereafter before the actual operation is resumed

Exploratory thoracotomy.—When growths are situated in the thoracic œsophagus thoracotomy may be deliberately exploratory in the first instance or it may have to be so regarded if it is not found possible to carry out œsophagectomy In the latter event an intra thoracic short circuit between the œsophagus above the growth and the stomach or jejunum may be carried out

THE CERVICAL REGION

Growths may be approached by an incision such as is employed for œsophagotomy Tracheostomy through a separate transverse incision is necessary If the growth is extremely small and strictly limited to the posterior wall of the œsophagus and if the larynx and trachea are not involved the œsophagus with the growth may be

readily isolated from its bed by blunt dissection with the finger If the growth is limited in longitudinal extent the pharynx above and the œsophagus below are divided and the involved segment removed. In these circumstances the gap between the ends may be bridged by a new tube constructed of a skin flap or flaps cut from the neck or by the insertion of a plastic tube covered with a Thiersch graft. The

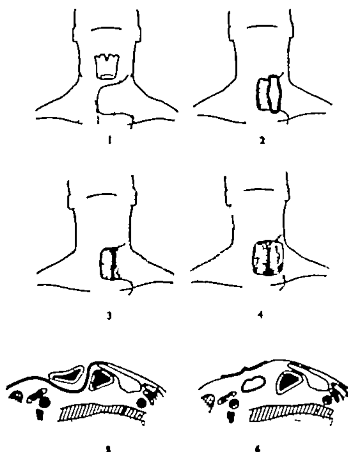


Fig. 733 —Cervical œsophagectomy with reconstruction

1 The skin flap outlined 2, the segment of œsophagus containing the growth completely separated from its surroundings and the skin flap tucked beneath it and fixed by suture 3, at the preliminary operation or four days later the affected segment is cut away The ends of the pharynx and œsophagus now open into the trough of skin formed by the flap 4 some three or four weeks later the flaps shown outlined are cut on either side of the trough and turned in over it, where they are sutured, converting the trough into tube replacing the excised portion of œsophagus 5, diagram of transverse section of neck showing flap laid under isolated portion of œsophagus. The right lobe of the thyroid gland has been removed 6, the œsophageal segment has been excised and the trough wrapped round and converted into tube over which the skin has been sutured.
(Modified from Pilcher *Lancet*, 1937.)

operation is usually carried out in two stages At the first the incision for exposure is made in the form of a large flap (Trotter) the affected portion of œsophagus is isolated and excised The skin flap is then laid in the bed from which the œsophagus has been removed in such a way as to form a gutter by uniting the upper edge to the cut margin of the pharyngeal wall and the lower edge to the posterior wall of the œsophagus.

The second stage consists in the transformation of the gutter into a tube to replace the œsophagus These points can best be understood by reference to Fig 788 The approach is usually made from the left side unless there is some special reason to use the right such as extension of the growth beyond the wall of the œsophagus or for instance involvement of the thyroid gland on the right side

The flap should be carefully planned and its extremity must extend beyond the middle line It should be taken from the space between the upper border of the larynx and a point above the sternum its base must be broader than its apex It includes the skin and subcutaneous tissue Great care must be taken not to injure vessels entering the base of the flap on which its nourishment may depend After the flap has been turned back it should be kept warm with moist gauze. The exposure is then made as described for œsophagotomy In cases really suitable for excision the growth lies loosely in its bed of cellular tissue from which it can readily be separated by the finger Extension to the thyroid gland or invasion of neighbouring lymph nodes does not necessarily mean that excision is impracticable but separation and removal must then be made under the guidance of the eye and cutting instruments will be required When the growth is fixed on the opposite side to that approached the operation should not be hastily abandoned but the area of fixation should be exposed by dissection an additional incision being made if necessary The condition may turn out to be more favourable than might have been expected When the parts outside the œsophagus are not invaded the recurrent laryngeal nerve usually escapes but if it is actually involved by growth it will have to be divided and a portion excised Even when not divided at the operation involvement in the scar leads to unilateral laryngeal paralysis If both recurrent nerves are involved it is an indication that the disease is advanced and the operation must be combined with total laryngectomy

When the œsophagus with the growth has been mobilized and there is a sufficient free portion above and below the parts are ready for excision. The pharynx should be cut across first but this should be done by stages each bit of cut edge being caught by forceps or by a stitch so that it is accessible for suture to the skin flap when the latter is placed in position When the pharynx has been divided the œsophagus with the growth can be held conveniently and a little traction applied so that the œsophagus below the growth can be seen and divided slightly obliquely But this should also be done gradually and the edges caught at several points to guard against retraction of the lower end into the mediastinum

The next step is to adjust the skin flap to occupy the gap between the two ends and to make a gutter as shown in Fig 788 (8) When the flap is in position the lower cut edge of the pharynx is sutured to the upper border of the skin flap This is best done by interrupted utures of fine chromic catgut with one or two of nylon passed in uch a way that the edges of the structures are turned slightly inwards

i e. towards what will be the interior of the new tube Similarly the posterior edge of the cut œsophagus is stitched to the lower border of the skin flap It is most important that there should be no tension and in any event one or two of the sutures should be of nylon and of the mattress variety to secure a very good hold The other edge of the œsophagus should be secured to the skin margin to prevent retraction and to protect the cellular tissue The œsophagus should be opened widely when sutured since this is the region at which a stricture is likely to occur The remainder of the cut end of the pharynx should be anchored to the skin in a similar way The gutter and the space between the ends of the pharynx and œsophagus respectively should be covered by oiled skin on to which gauze can be lightly packed

If gastrostomy has not been carried out a feeding tube with a lateral hole is inserted into the œsophagus This may be passed through the nose or directly into the open end of the œsophagus from the neck wound Gastrostomy is not necessary unless required before the cervical operation to improve the nourishment of the patient if performed it does away with the difficulties of feeding but even so there will be continuous soakage of the neck dressings by saliva. As soon as the patient can manage to do so he should be encouraged to expectorate frequently but in the early stages the gauze which is only lightly packed should be changed frequently and free use should be made of the suction apparatus The constant attention of a special nurse properly trained to deal with such cases is almost essential if they are to be carried to a successful conclusion

If all goes well the area will be gradually sealed off by granulations later replaced by fibrous tissue so that in two or three weeks the pharynx on the one hand and the œsophagus on the other will be incorporated with the upper and lower ends of the gutter Primary union often occurs but there should be no haste in attempting to complete the formation of the dermal tube

The final stage consists in completing the tube by turning in skin flaps to make the anterior wall and this is done in much the same way as for the dermal tube in the formation of the ante-thoracic œsophagus (*see* p 1767) Incisions are made in the lateral superior and inferior boundaries of the gutter and the skin is undercut so that the margins can be folded in and sutured together in a tubular manner The outer raw surface is covered by undercutting the skin at the side of the neck so that it can be sutured over the newly made dermal tube or by generous skin grafts The main difficulty is to secure enough skin for this purpose and skin-grafting may be required After about three weeks in satisfactory cases union will be firm enough to allow natural swallowing

The constricting type of carcinoma may occur in the cervical œsophagus and may be present as a small very well localized lesion. In these circumstances it may be completely separated from its connections and left *in situ* in front of the skin flap which is passed behind

it as shown in Fig 788 The object of this is to allow the cellular tissue to become shut off and the œsophagus fixed at the ends before the affected portion is cut away The actual excision may be delayed for about four days and should be made with the electro-cautery In spite of the time allowed for connections to form it will be safer to put in a few sutures between the cut ends of the œsophagus and the skin flap This modification has however no particular advantages and it is usual to excise the segment of œsophagus at the first stage as already described

When the growth is low down in the cervical region or extends into the upper mediastinum it is usually supposed that the operation must be abandoned but this is not always necessary In these circumstances the growth may often be removed as the œsophagus in this situation readily lends itself to separation from the cellular tissue bed in which it lies Preliminary gastrostomy is essential. Blunt enucleation of the œsophagus may be carried as far as the arch of the aorta but to carry it so low excision of the inner end of the clavicle with perhaps the upper corner of the manubrium sterni is a great help The separation is entirely carried out by the finger When a point well below the growth has been reached the œsophagus must be occluded by ligature. It is first crushed with a right angled clamp *and then very firmly ligatured with thick chromic catgut* The application of this ligature is a difficult step and it may prove easier to transfix the œsophagus with a ligature on a needle After being securely tied the œsophagus is divided with the cautery knife or scissors In any case the divided end is smeared with one of the sulphur group powders or Bipp which is also rubbed into the surrounding cellular tissue. The upper end with the growth is brought out of the incision and fixed well outside the wound and is then divided about half an inch beyond the surface or the mass may be wrapped in gauze its removal being deferred for about 48 hours by which time the cellular planes in the area will be sealed by exudate By either plan if retraction is prevented a satisfactory fistula results In these circumstances restoration *in situ* is not feasible but continuity may be established by the formation of a new œsophagus.

Extension of a growth at the mouth of the œsophagus into the posterior wall of the larynx and trachea is so common that recurrence follows the great majority of operations in which the larynx is preserved For this reason and because irradiation is ineffective in this disease the correct procedure for an extensive growth is removal of the larynx together with the lower segment of the pharynx and the upper end of the œsophagus

Under present-day conditions the operation has no undue dangers and the results are scarcely more disabling than those of total laryngectomy

The gullet can always be reconstructed and the only disability is the loss of laryngeal speech Patients can however learn to speak by means of an artificial larynx or by the method of air swallowing

The operation was introduced many years ago by Gluck

Pharyngo-œsophago-laryngectomy—The removal of the growth follows set lines but the subsequent repair can be carried out by alternative methods

In the original operation a midline incision with transverse incisions at the level of the hyoid bone and about 1 in above the clavicle allows quadrilateral flaps to be dissected back We now employ a vertical incision to one side of the midline with a downward curved transverse incision above and an upward curved incision below This produces two lateral flaps of unequal size This is followed by removal of the fascia with any glands block dissection is carried out first on the side of greater affection together with the internal jugular vein of one side only if infiltrated. After trying the internal laryngeal vessels on each side the hyoid bone is dissected free and the pharynx is opened above it according to the extent of the growth The hyoid and larynx are then removed from above downwards the lateral and posterior walls of the pharynx being divided well above the growth Anæsthesia is continued through an endotracheal tube until the trachea and œsophagus have been freed from their attachments

The thyroid gland on the more affected side should be removed or even the whole gland if infiltrated The giving of thyroid extract and of intravenous calcium is required after complete removal to prevent myxœdema and tetany

The trachea is cut across below the third ring or even lower and the œsophagus is divided well below the growth this being just above or at the level of the sternum If no attempt at immediate repair is to be made the skin flaps are then brought together over the front of the vertebral column and united by sutures of black silk to the cut pharynx above and the trachea and œsophagus below Tracheostomy and rubber feeding tubes are inserted

Repair of pharynx.—(*a*) If equal flaps have been used incisions are made to either side of the midline and below the chin after a lapse of four weeks Skin flaps are freed turned in and united to form a tube The skin at the side of the neck is then undercut to enable flaps to be brought in to cover the raw surface of the dermal tube. (Fig 788)

(*b*) A method employed by Wookey of Toronto makes use of one large flap rolled over on itself to form a gutter which is subsequently closed by plastic repair

(*c*) It is possible to combine lateral flaps each rolled on itself with a central skin graft covering an area between the two flaps over the raw vertebral column This should allow of easier subsequent repair

(*d*) A method of primary closure first introduced by Rob and subsequently modified enables the operation of removal of the gland area and growth and repair of the pharynx to be carried out at one stage Having removed the area as described above a large plastic or rubber tube with an expanded upper end is placed in position on the pre-

vertebral fascia the upper end at the base of the tongue and the lower inserted into the divided œsophagus two or three catgut sutures are used to anchor it at either end

A large skin graft is cut and wrapped round the tube with fine fixation stitches above and below The skin flaps which should be of unequal sizes with a vertical incision to one side of the midline are then brought over the tube and graft and united with black silk sutures Both local and general antibiotics are essential. The tube is removed after three weeks The method has the advantage of allowing the patient to swallow saliva and later nourishment without leakage in the neck.

Results.—By one method or another it is possible to restore natural swallowing and this is obviously far preferable to the former use of a rubber tube of Gluck s type connecting the two divided segments of the food passage

It has been hoped that the one-stage operation can be generally adopted to save the patient the delays and discomforts of repeated procedures

The plastic tube has in some of our cases been left in for six months the patient meanwhile swallowing by mouth Unfortunately however there is trouble with stricture formation and for this reason it appears advisable to remove the tube after three weeks

If a subsequent stricture forms usually at the junction of skin tube and œsophagus and if it is not readily controlled by dilatation then it may be necessary to reoperate and after excising the contracted scar tissue to turn in skin flaps

THE THORACIC REGION

There are three possible routes of approach the trans-thoracic (Torek) the collo abdominal or pull through method (Grey Turner Denk) and the posterior mediastinal (Lilienthal) At the present time the first method is almost universally employed and the other plans are usually regarded as obsolete

The Trans Thoracic Route

This was the approach adopted by Torek in dealing with his first notable success Many surgeons have conscientiously worked at this method and have practised it on many occasions but it is only during the last few years that many successful cases have been reported (King of Melbourne Garlock of New York Franklin of London Allison of Leeds and now a host of surgeons throughout the world.)

The method has the overwhelming advantage that the operation can be carried out under the guidance of the eye In the earlier operations the *left* pleural approach was always employed but anatomical observation and consideration* suggested that the *right*

* O'Shaughnessy and Raven, *Brit Journ. Surg* 1934 xxii 365

pleural cavity commanded access to a greater extent of the œsophagus and was therefore probably more suitable. Having tried both routes it is advised that for growths situated in the lower third of the œsophagus the left approach is the more suitable whereas for growths in the upper two-thirds the right gives a better exposure. The more general adoption of the method of restoration by displacement of the stomach into the chest is now bringing the left-sided approach into favour

Technique.—The general preparation is the same as for any interference with the œsophagus while the anæsthetic requirements and methods and the general technique are as employed in thoracotomy for any purpose and are described in Vol. I p 852. The patient must be placed comfortably on the side right or left depending on the pleural cavity to be approached and the uppermost arm is elevated and supported. A skin incision is made along the length of the seventh or eighth interspace from its anterior end right backwards and then upwards parallel with the vertebral border of the scapula as high as the third rib The muscles are incised down to the intercostal space great care being taken to catch and ligature all bleeding points This part of the operation may be carried out with the diathermy needle which may perhaps save a little time and blood loss. *The edges of the incision having been retracted* and the whole intercostal space exposed the latter is opened at its anterior end. The incision of the pleura should be small at first and only gradually increased using scissors until it extends along the whole length of the space. After the pleura is freely opened a moment or two should be allowed for the patient to settle. When breathing is quiet the rib spreader is inserted and the ribs are slowly and steadily separated until the chest cavity is freely opened and the whole hand can easily be introduced into the chest The extent to which the ribs can be separated varies very much in different subjects When the spread is inadequate the two ribs immediately above and below the intercostal space should be divided just in front of the articular processes This is to be done with great care for there is some risk of hæmorrhage from torn vessels Instead of relying on spreading some operators prefer to gain room by removing one or two ribs The lung can then be gently displaced forwards and upwards exposing the œsophagus by the side of the vertebral column and in close proximity to the aorta (Fig 784) manual retraction is better than the use of instruments but whatever method is used great care must be taken not to traumatize the lung

When the site of the growth has been verified very careful examination must be made to determine its relation to the surrounding parts Fixidity as the result of infiltration or widespread involvement of the lymph nodes are contra indications to removal. There may be obvious extension to the pleura the lung or the pericardium and if so the operator must use his judgment as to whether or not the involved area

can be safely removed with the growth If there is no evidence of such implication it is a good plan to distend the cellular tissue around the œsophagus by injecting two or three ounces of local anæsthetic (0 5 per cent procaine) This not only makes it easier to separate in the cellular tissue but helps to thrust the opposite pleura aside. The mediastinal pleura covering the œsophagus is incised and a finger introduced into the cellular tissue is gently insinuated upwards by the side of the growth It is usually easy to carry the finger up beyond the growth behind the œsophagus and often on the inner side but many growths seem to become attached anteriorly to the structures at the

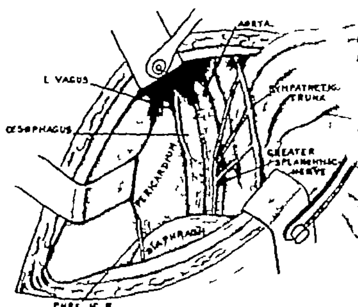


Fig. 734.—Transthoracic exposure of the œsophagus from the left side.

root of the lung An attempt must be made to separate in this situation and as the finger is insinuated it must be used to push the structures gently aside rather than to force them apart. Sometimes the growth is very readily isolated in this way and the finger can be passed around it with ease If the œsophagus cannot be separated from its surroundings by gentle manipulation it is unwise to use force as the removal of growths which have to be dug out in this way is never attended with happy results If immediate recovery follows early recurrence is the rule. It is easy to tear into the growth in which case infection is almost sure to follow with fatal result In the happy event of the separation being easy the œsophagus must be freed to a point at least 2 in. below the growth It is convenient to pass a tape or a pair of ring forceps around the œsophagus so that it can be drawn somewhat into the pleural cavity where it is more accessible. When the point of division below the level of the growth has been decided the muscular

wall of the œsophagus is gently incised with a knife until the submucous tissue is reached. An encircling ligature is then tightly applied so as to occlude the mucous membrane. The remainder of the œsophagus may now be cut across with the diathermy knife or the scissors. The lower end is smeared with sulpha group powder and the ligature divided when the mucous membrane will retract into the muscular tissue or may be tucked in without difficulty One or two sutures which have already been placed are then used to draw the muscle coats together burying the ligatured mucous membrane. When the division has to be made very near the diaphragm there is a risk of the lower end retracting through the hiatus. To avoid unfortunate *consequences from this accident the ligature of the mucous membrane* must be very secure. There are some considerable vessels in this situation and these may require independent ligature. When the growth is very near the diaphragm that muscle can be freely incised in order to draw the cardiac end of the stomach up into the chest so that the viscus may be divided well below the growth and carefully repaired by suture The upper part of the œsophagus which is to be removed must now be securely held by its ligature, while the cut end is protected by gauze or a rubber cap securely tied over it To some extent it may then be lifted away from its bed but separation by the finger in the cellular tissue must be carried out towards the root of the lung and eventually behind it and the arch of the aorta (Fig 785) It greatly facilitates this stage to divide some of the intercostal arteries between carefully applied lightly tied ligatures. If the cellular tissue is condensed rather than infiltrated a growth may be separated from the aorta but great gentleness is required and the only instrument permissible is the pulp of the finger Sometimes a tiny branch is torn so close to the aorta that it cannot be caught for ligature in these circumstances the orifice should be surrounded by a fine purse-string suture in the adventitia which will usually suffice to arrest bleeding On the right side the azygos vein makes a very definite wide arch which can readily be seen and usually avoided Where the arch is small or where the growth is adherent at this point or very bulky the vein may be doubly ligatured and divided The surgeon must now decide if the operation is to be completed by the original method of Thorek or if restoration is to be attempted *in situ* The latter is the usual practice to-day the divided œsophagus being reunited to the stomach, which is mobilized and drawn up into the chest

It may help the process of separation to incise the mediastinal pleura above the level of the arch of the aorta or the azygos arch as the case may be so that the finger can be more readily introduced into the cellular tissue in this situation but this part of the œsophagus is usually better separated from the neck.

When the œsophagus has been mobilized as high up as possible the bed from which it has been removed is very carefully inspected and all bleeding points are caught and tied or arrested by silver clips. When quite dry it should be smeared or dusted with sulphanilamide powder

The edges of the pleura are drawn together here and there with interrupted sutures of catgut A rubber tube should be laid in the lower part of the œsophageal bed or at least in the vicinity and brought through the parietes by an independent incision so that it can be drawn up into the neck If the surgeon feels sure that the œsophagus is completely separated from its thoracic connections the chest may now be closed thus completing the thoracotomy part of the operation

The growth if very bulky instead of being drawn up through the superior mediastinum into the neck as in the original method may be cut away and removed in the thorax leaving only the upper end of the œsophagus to be eventrated If there is any doubt about the complete separation of the gullet the thoracotomy is not closed but temporarily packed with a large swab and thoroughly covered with warm moist towels or the skin may be drawn together with a few strong sutures over a large swab The patient is then turned gently and quietly on to the back and the root of the neck exposed with the shoulders elevated and the head turned to the right side

It is well to give the patient a few minutes rest before proceeding with the next stage of the operation and during this interlude to take stock of the general condition An oblique incision along the anterior border of the sternomastoid can be used for the exposure of the cervical œsophagus as in œsophagotomy but we have found that better access is obtained by an incision parallel with and just above the clavicle the sternomastoid being completely divided in this line The œsophagus is then exposed as in œsophagotomy and must be gently separated from the surrounding parts by blunt dissection with the finger care being taken to avoid the recurrent laryngeal nerve As a rule this nerve is not seen and practically always escapes injury As soon as the finger can be hooked round the œsophagus it may be replaced by a loop of tape or the ring forceps while the process of separation is carried on downwards with the finger passed into the upper mediastinum In fortunate cases the finger will meet the growth and can be swept all round it. As soon as this has been done or when the cellular plane opened up from below has been reached gentle upward traction is made and then the isolated œsophagus can usually be drawn easily into the neck Sometimes it is still firmly fixed in the thorax despite the fact that it appeared to be completely mobilized from below In these circumstances while traction is kept up the surrounding parts may be gently pushed aside from the neck wound with the finger or a pledget of gauze held in long forceps. If this does not suffice to release the œsophagus the patient should be turned over and the thoracic cavity again exposed so that separation may be completed by working from the chest or chest and neck together Once the œsophagus has been completely mobilized it can be withdrawn from the neck and allowed to hang out of the wound The next point is to decide the most convenient spot for it to lie over the clavicle When this has been settled the sternomastoid is drawn together about the œsophagus which is attached to the muscle by one or two catgut

stitches The skin incision is then carefully closed around the œsophagus which at the end of this stage of the operation will be hanging freely over the front of the chest Its subsequent disposal has already been discussed (p 1780)

This stage having been accomplished a return may have to be made to the thoracic cavity The gauze is removed from the œsophageal tunnel and one or two other small vessels in the tunnel may have to be tied or occluded by silver clips A careful scrutiny is made for swabs to be removed and for blood clots. The toilet of the pleura having been completed the chest is then closed and the patient is ready for return to bed. The drainage tube is put under a water seal and will probably have to be left *in situ* for about 48 hours



Fig 735.—Resection of a portion of the thoracic œsophagus for carcinoma.

The œsophagus is being freed by blunt dissection from under the aortic arch several small arteries enter the œsophagus here, and must be isolated and ligatured separately (Reproduced, by permission, from B. Noland Carter *Surg G)* *and Obst* 1940, lxxi, No. 5)

Throughout the whole operation great gentleness must be observed there must be no haste and twice or thrice during its course all manipulations should cease and the patient be allowed to rest for a few minutes Blood transfusion as required will be administered during the course of the operation. Fresh instruments and gloves should be used for each stage. The whole proceeding may take 2½ to 3½ hours or even longer

Restoration within the thorax.—When this is to be carried out the divided upper œsophagus is allowed to retract with the guide sutures easily accessible The diaphragm is then incised radially from the hiatus in the direction of its fibres outwards and forwards for about 3 in The œsophagus is freed from the hiatus by dissection and the fundus of the stomach is drawn into the chest to the necessary extent If the diaphragm is very adherent or actually invaded a portion of that structure must be excised *en bloc* with the œsophagus Such invasion is more likely to occur behind than in front The vessels along the cardiac end of the stomach are caught and tied and attention is turned to the left gastric artery To reach this vessel some of its branches must first be caught or divided and this will help to expose the

trunk which is separately dealt with As a rule this will enable a sufficient portion of the stomach to be drawn up into the chest but if not further ligature of vessels will be necessary It will suffice for nutrition of the viscus if the right gastric and the right gastro-epiploic arteries are preserved intact It is not essential to remove the spleen but sometimes the mobilization of the stomach will be greatly facilitated by so doing or at least by dividing some of the vessels to its upper pole without necessarily dealing with its main pedicle. When the stomach is sufficiently mobilized and displaced to allow easy approximation to the œsophagus at the point at which the latter has been divided its posterior surface should be fixed by a stitch or two to the diaphragm The œsophagus is then freed from the stomach by cutting across that viscus just below its attachment so as to include a cuff of stomach wall. It is convenient to control this part of the viscus by a light clamp The incision in the stomach is carefully repaired by sutures at either end leaving only a sufficient portion about the centre for the anastomosis.

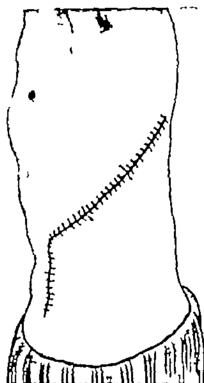


Fig 736 —Incision for œsophagectomy

The opening into the stomach should be a little larger than the diameter of the lumen of the œsophagus at the point at which it is to be anastomosed. There must be no suspicion of tension between the two viscera. It is not really necessary to clamp the œsophagus though a clamp does form a convenient handle but it must be the lightest of instruments for the œsophagus will not bear crushing

With easy approximation of the parts to be joined it should not be necessary to insert posterior sutures one by one as the œsophagus is divided but that method can be employed. The union is made end to side i e. end of œsophagus to side of fundus of stomach. A posterior row of mattress sutures makes the safest union Each stitch should take a good hold of the mucous membrane but they should not be big bites—an eighth of an inch will suffice or each stitch should be about the same distance from its fellow The opening should not be cramped up during the suturing as it will probably contract to some extent in any event and there have been instances of a stricture developing

The anterior part of the anastomosis can be completed by through and through interrupted sutures or partly by a continuous stitch The line of the anterior anastomosis can be covered by a few sutures used Lembert fashion They must not be drawn tight or they will be

sure to cut out of the muscle of the œsophagus Easy apposition is the aim

After this suturing is completed the adjoining stomach wall is pulled up partially to cover the suture line so that the anastomosis is more or less covered A few extra sutures between the œsophagus and stomach to diminish the risk of tension will be wise

The next step is to complete the suture of the stomach to the diaphragm in front to take any drag off the anastomosis and to prevent herniation of omentum or intestine into the chest. The remainder of

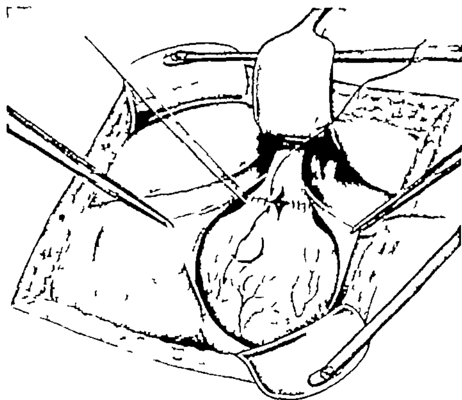


Fig 737 —Œsophago-gastrostomy The anastomosis.

the diaphragmatic incision should also be closed by suture. The *displaced stomach with the anastomosis and the œsophagus* are laid into or against the area from which the œsophagus has been enucleated and a few stitches are inserted here and there between the edges of the incision in the posterior parietal pleura and these structures mainly with a view to keeping the parts in position and to prevent drag The toilet of the pleura is attended to and the chest closed This type of restoration has usually been made just below the aortic arch or just external to it but it has been made above that structure or even above the clavicle the stomach being displaced into the neck for that purpose and the anastomosis made through an incision in the posterior triangle. In each of these several situations union has been effected with complete success Sometimes the mobilization of the stomach is carried

out from an abdominal incision as described at p 848 If for any reason the stomach cannot be sufficiently mobilized because of its fixation by adhesions for instance or if it will not lend itself to displacement because it happens to be unusually small a portion of jejunum may be brought up and united to the œsophagus in the same way as the stomach Some surgeons prefer to use segments of small intestine to restore the passage because of the peptic ulceration which sometimes follows anastomosis with the stomach If primary reunion is not to be attempted the upper end of the œsophagus must be drawn out of the neck

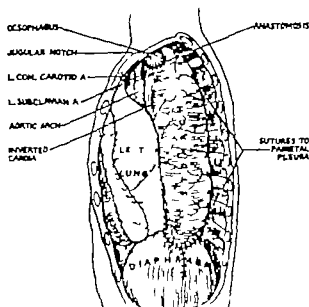


Fig 738 —Œsophago-gastrectomy completed. Note the closure of the opening in the diaphragm.

Either a loop of jejunum can be used, the anastomosis being made to its summit or the jejunum may be divided the open distal end being used for the anastomosis to the œsophagus continuity of the jejunum being restored by an end-to-end anastomosis lower down In either case great care must be taken to avoid tension and all pull or drag on the anastomosis must be prevented The closure of the diaphragm must not be tight enough to constrict the stomach or intestine

The Collo-abdominal or Pull-through Method

This operation was devised and elaborated during the period when the trans-thoracic route was attended by so many disappointments that most surgeons were in despair about the future of radical operations for cancer in this situation The method presupposed a growth entirely limited to the œsophageal wall and without fixation of any sort and was largely carried out without the guidance of the eye The first completely successful case was published in 1988* and aroused renewed interest in the subject of œsophagectomy In spite of some few further successes it was very soon superseded by better and more rational methods and can now only be regarded as one of the milestones in the remarkable developments in œsophagectomy which have taken place since that time

The technique is described in the last edition of this work

* Turner Lancet, Dec. 9 1933, p. 1315

Posterior Mediastinal Approach

At this stage in the development of œsophagectomy for cancer this approach must be regarded as obsolete and only of historic interest.

The Lower End

The technique of this operation is described and illustrated in the section on the Stomach (Chap XV Vol. I p 848) and attention is particularly drawn to the illustrations (Figs 854 to 862 inclusive) When there is any suspicion about extension of the growth below the diaphragm or as to the probability of secondary deposits the abdominal part of the incision should be made in the first instance for exploration. But whichever the approach the surgeon must not hesitate to extend the field of operation in order to secure the freest exposure so that every step can be carried out under the guidance of the eye and unhampered by restrictions of space. Sometimes a great point has been made of the suture material to be employed but accuracy in the placing of the sutures and the actual stitching is much more important than the material used Allison pointed out the importance of preventing the overflow of œsophageal or gastric contents into the bronchial tree during the operation and recommends placing a temporary tampon in the œsophagus at the outset and also using a clamp on the structure during manipulations to prevent reflux. In the further hope of improving the long term results it is suggested* that the excision should include the greater part of the lesser curvature of the stomach the whole of the gastro-hepatic omentum and the left gastric vessels with the associated lymph nodes right back to the cœliac axis with still further extension in some cases Completion by anastomosis of the œsophagus to the stomach is an essential part of the intervention which does not lend itself to a staged proceeding

In operations of this magnitude the care of the patient is of great importance and the services of an anæsthetist skilled in this branch of work is essential The care of the patient must include the supervision of blood transfusion and the other supportive measures which are so helpful and necessary

When the growth is in the extreme lower extremity of the œsophagus it may be limited to that part of the tube which lies *in the abdomen*. In these circumstances it may be possible by an abdominal exposure to mobilize and excise the growth and to make a direct anastomosis between the divided end of the œsophagus and the stomach. There are very few cases in which the growth is sufficiently localized to make this sort of operation possible and in the great majority the growth demands the removal of so much of the œsophagus that a direct anastomosis to the stomach cannot be made within the abdomen. The best method is a combined abdomino-thoracic approach or a *trans-thoracic approach with incision of the* diaphragm (thoracolaparotomy) The stomach is displaced into the thorax so that union

* Allison *Proc Roy Soc of Med* Feb 6, 1946, xxxix, 411

by suture between the divided œsophagus and the fundus can be effected These operations though technically feasible have been followed by a high mortality Recent modifications such as burying the union in the stomach fundus hold out greater promise and there are now many successes reported (Garland Brock Sampson Turner)

After treatment.—Shock is not a marked feature at first but there may be some delayed hæmorrhage and in any case blood transfusion is wise in the immediate post-operative period. The patient should be nursed in an oxygen tent morphia will certainly be required at first Tension pneumothorax infection of the pleura and a low form of pneumonia are recognized risks In some cases a localized empyema has required drainage When the œsophagus is eventrated arrangements must be made to collect the saliva from the upper end and if that is done the patient may if so desired be allowed to drink almost from the first for its psychological value The after-care is in general that required for thoracotomy Constant watchfulness is necessary for some days and X ray examination may be most helpful Aspirations of the pleural cavity may be required more than once even if drainage has been provided When restoration has been made by anastomosis of the œsophagus to the displaced stomach fluid may collect in the viscus and this may be added to as the result of œdema, which may also temporarily obstruct the anastomosis

In these circumstances repeated aspiration of the stomach may be necessary and to facilitate this a Ryle's tube may be left *in situ* at the time of operation. If the patient can readily swallow without ill effects there seems no objection to nourishment by the natural route at the end of 24 or 48 hours but sometimes it may be days before more or less normal swallowing capacity returns To tide the patient over this period blood transfusion and also intravenous nutrition will be most important and biochemical problems may arise. Sometimes secondary jejunostomy may be required

The fate of the vagus nerves in œsophagectomy—In most operations for removal of some part of the thoracic œsophagus one or both vagi will be divided or a section removed This does not appear to have any notable effect on the progress of these cases though it may be the cause of some of the difficulties in restabilizing the swallowing mechanism We are aware that its consequences have not been sufficiently investigated by scientific methods

Restoration of swallowing after œsophagectomy—In addition to the methods which have already been described reconstruction has been made by displacing the mobilized stomach into a subcutaneous channel in front of the sternum and then making an anastomosis to the eventrated œsophagus brought over the clavicle (Hermon Taylor) This plan is supposed to have the advantage that if anything goes wrong with the anastomosis and there is resulting leakage a fatality is not inevitable for the defect may be capable of repair

whereas this would be unlikely with the intra thoracic methods Another possible advantage is that this plan may be a staged proceeding Successful cases have been recorded.

As a purely temporary measure the œsophageal fistula about the clavicle may be connected to a gastrostomy by a rubber tube. As a method of election this plan should be regarded as quite obsolete but it played an important part in the evolution of restoration after œsophagectomy and may sometimes be employed as an expedient The adjustment of the tube in order to prevent leakage has been troublesome but in some cases such an apparatus has proved quite satisfactory

Results of œsophagectomy for cancer—This still remains what some regard as a mournful record as recurrence within a few months often takes place and few cases survive for more than two or three years None the less considering the comparatively recent development of this difficult branch of surgery there are many encouragements

A pioneer such as Garlock found that in about 50 per cent. of the patients that he explored the disease was removable with a primary mortality of 30 per cent Among 32 surviving cases one was alive and well 12 years after operation another 11 years and twelve over 5 years which must be regarded as a wonderful record Though there are still many difficulties to surmount the primary mortality is gradually diminishing without any retreat from bold intervention. Undoubtedly there are many disappointments but these must be accepted as a challenge to further study and effort. At this stage it is most important that surgeons should not be too easily deterred in developing this comparatively new branch of surgery

Sequelæ.—Ulceration at the line of anastomosis has often been noted It has the characteristics of peptic ulcer of the œsophagus and management must be on the usual lines including rest attention to diet and very *frequent doses of bismuth in the dry form* The sitting or reclining posture helps to prevent reflux of gastric juice. Ulceration may be associated with hæmorrhage or perforation.

Stricture also occurs and often without previous symptoms of ulceration The timely use of bougies is usually successful in its management One of the worst troubles is regurgitation after food and during sleep when it is most distressing as it is often accompanied by aspiration into the larynx and trachea. It is probably the result of the loss of the guardianship of the cardiac mechanism. There is no doubt it is less in evidence when the patient is in good general condition and is occupied Unfortunately sound sleep is not a deterrent There is no specific treatment but to a certain extent it can be mitigated by avoiding food for two or three hours before bed time and by resting more or less in the propped up or reclining position Alkalis in powder form and especially barium are helpful.

If it is possible to maintain the lumen of the œsophagus and thus to allow of more or less normal swallowing a great boon will have been bestowed on the patient Not only can sufficient nourishment be administered to maintain strength but the saliva can be swallowed Gastrostomy will permit of adequate nourishment but there may come a stage when it does not overcome the difficulty of disposal of the saliva.

PALLIATIVE METHODS

Dilatation.—Simple dilatation of a malignant stricture gives temporary relief If it can easily be repeated the swallowing act may sometimes be preserved almost until the time of death from dissemination. The blind passage of bougies is especially dangerous in malignant cases but sometimes a Hurst s mercury filled bougie will slip through a growth with ease and may be used repeatedly with benefit Or the Vinson string guide may be successful

Dilatation under direct vision, through an œsophagoscope is readily carried out but its benefits are only temporary Gum-elastic bougies may be used or preferably a dilatable bag on a flexible hollow stem To get the full advantage of the method it must entail repeated dilatation at such intervals as will preserve the swallowing capacity

Intubation.—The lumen of the œsophagus may be maintained by a tube passed through the growth and left *in situ* This is the method of intubation introduced by Charters Symonds though the gum elastic tubes which he used have now been superseded by the spiral silver or stainless steel wire tubes of Souttar which may remain in place unobstructed for several months The constricting growth is first examined through a wide bore œsophagoscope and the lumen is found and dilatation is carried out with graduated bougies or a bag A fine guide is introduced and on it is threaded the flexible intubation tube to be inserted through the stricture by means of forceps or a special tubular introducer A collar on the upper end prevents the tube from slipping through the growth while the spiral structure of the instrument prevents its expulsion. All food must be finely divided otherwise the tube gets blocked. But fairly thick varied diet can be taken provided that lumpy food is avoided The tube may slip through the stenosis owing to its dilating effect or the carcinoma may grow exuberantly and obstruct its upper end. Even though the tube slips out of place and passes into the stomach no untoward symptoms should arise as it will traverse the intestinal tract without difficulty there is the disadvantage however that another tube must be inserted

Methods of irradiation have given favourable results in our hands and are sometimes to be preferred.

Irradiation.—The inaccessibility of the œsophagus makes distance irradiation a matter of difficulty since the rays must pass through the lungs Local application of radium or radon is also unsatisfactory

since it is impracticable to determine the complete extent of a growth or to irradiate all parts of it

A few cases respond satisfactorily to high voltage deep X ray therapy but the method is tedious and disturbing and the results are seldom permanent

Palliation of symptoms can be obtained more easily by interstitial *irradiation usually with restoration of free swallowing for some* months but without cure

Many methods of superficial irradiation have been adopted in the past such as application of radium or radon through the trans-thoracic route insertion of an intubation tube with the radio-active agent attached to its surface or by the use of a silver capsule within the lumen of the œsophagus

In our experience the most satisfactory method is the insertion into a growth of radon seeds *carried in a tube of polythene three or four* columns with four or five seeds in each being employed each seed is of 1 8 mcr screened with gold or platinum of 0·6 mm. thickness. The columns of seeds are introduced by means of a special applicator introduced through a wide bore œsophagoscope after careful estimation of the distribution and length of the growth (Fig 789) The seeds are inert after 10 days and are left in position

After some months of more or less normal swallowing the patient dies of asthenia or of *infection of the lungs or pleura following per* foration

Gastrostomy is the usual means by which the principle of short circuiting is carried out Not only does it enable the patient to receive sufficient nourishment but it protectes the growth from the traumatism and sepsis incidental to the passage of food. To get the best results it is essential that the operation should not be too long delayed and that the feeds should provide a properly balanced mixed liquid diet. For psychological reasons some fluid nourishment should be permitted by the mouth as long as the patient can swallow In order to keep the lumen of the growth free from débris and mucus it is a good plan to allow the patient to sip small quantities of a solution of peroxide of hydrogen of a strength of 1 in 10 at frequent intervals. When gastrostomy or feeding by œsophageal tube has been too long delayed and the patient is seriously debilitated nutrition by intra venous injection should be instituted for some hours before the operation is carried out otherwise the primary *mortality is likely* to be very high

Gastrostomy may also be desirable in certain cases where the trachea or bronchi are invaded and perforated by the growth and where great distress is caused by attempts at swallowing The technique of the operation is described at p 858 Vol. I

Other methods of short-circuiting.—Direct anastomosis of the œsophagus on the proximal side of an irremovable growth to the stomach or the jejunum has also *occasionally been carried* out with

benefit to the patient In all probability this method will only be considered when at an exploratory thoracotomy it is decided that œsophagectomy should not be attempted

Technique.—In these circumstances the œsophagus will have been exposed by incision of the overlying pleura and mobilized to some extent Probably a lateral anastomosis will be contemplated. The site for the opening in the œsophagus should be an inch or more above



Fig 739 —Radon seeds in position in a growth.

the upper limit of the growth in order to make it less likely that it will be invaded by an advancing neoplasm The infiltrated area is marked by a couple of guide sutures with the ends left long The diaphragm must next be incised and a portion of stomach mobilized and drawn up into the chest to a point where it can be approximated to the selected area of the œsophagus without tension The anastomosis is then made as already described

The base of the cone of stomach must be sutured at a few points to the diaphragm and to the thoracic wall in order to diminish any drag on the anastomosis

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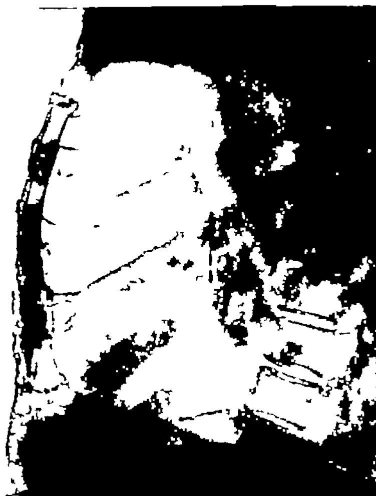


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It is not usually convenient or practicable to clamp the œsophagus but a small opening should be made into the lumen in the first place so that any content may be removed by aspiration or by careful mopping the anastomotic opening should not be less than 1½ in. long as there is a tendency to contraction If for any reason it is not practicable to draw up the stomach a loop of jejunum may be used.

It might be thought to be a good plan to cut across the œsophagus and to implant the proximal end into the stomach but if that is done the difficulty is to deal with the lower end of the œsophagus where secretion and débris may accumulate and cause leakage into the pleura or cellular tissue

The mortality of these interventions has been high and life has only been prolonged for a matter of months but the preservation of the priceless comfort of the function of swallowing has been judged to be well worth while

ŒSOPHAGECTASIA

ACHALASIA CARDIOSPASM PHRENOSPASM

There is as yet no standard method of treatment for this condition. The proper management will probably depend on the causation, which is not yet understood and the stage at which relief is sought.

Curative methods.—It should be recognized that some of the early cases can be cured by the use of intelligent and persistent dilatation by one of the methods in common use. At the Mayo Clinic great success has attended the use of the hydrostatic dilator (the Plummer Vinson dilator) as devised there nearly 50 years ago and used regularly ever since in thousands of cases. Negus and others have had notable success with the expansile bag passed through an œsophagoscope under the guidance of the eye and distended by water regulated by hand pressure.

The mercury bougie as advocated by Sir Arthur Hurst * has also proved valuable if used according to his precise directions In many cases where it has said to have failed these directions have been much neglected As the bougie has to be passed frequently and this may be difficult and painful it has largely fallen into disuse Retrograde digital dilatation through the open stomach (Mickulicz) is now obsolete though of historic interest The residue of cases not permanently relieved by dilatation should not amount to more than about 8 per cent. to 5 per cent and these will require some type of operation on the lower end of the œsophagus These methods include cardiotomy (Heller) cardioplasty or œsophago-gastrostomy they may prove satisfactory and lead to lasting cure

A great many other plans have been tried or are still on trial but have not yet been sufficiently tested to be recommended. Among the *palliative methods* the regular removal of stagnant œsophageal débris the self passage of weighted bougies and short-circuiting by gastrostomy have each proved beneficial

* Hurst and Rake, *Quart. J. Med.* 193[illegible], xxiii, 491. Grey Turner *Injuries and Diseases of the Œsophagus*, p. 69

Thus the surgical treatment of this condition may take many forms depending on the various interpretations of the pathology of the disease When surgical treatment is not contemplated periodic *removal of the stagnant food* by siphoning and lavage with a stomach tube or by occasional clearance through the œsophagoscope is of great help as a palliative measure as it makes the patient more comfortable and counteracts the tendency to œsophagitis As the condition is not fatal life may be carried on in comparative comfort with the help of permanent gastrostomy

Dilatation as a method of treatment is of value For this purpose *Hurst s mercury bougie* has been extensively used in the past with some success but is now superseded by dilatation with a hydrostatic bag passed through an œsophagoscope Hurst s tube is lubricated with liquid paraffin or olive oil and is easily swallowed after a short training In uncomplicated cases it gives relief and in some few cases may be curative

Dilatation under the guidance of the eye through the œsophagoscope is of considerable help and is now the accepted method of choice.

For *dilatation with an expanding bag* a wide-bore œsophagoscope is necessary if a large bag is to be passed under direct vision the circumference of the instrument preferred is 60 mm but one of 48 cm will suffice (*see* p 1741) The head and shoulders of the patient must be well depressed to expose the diaphragmatic hiatus but in most patients it is possible to obtain a clear view even with so large an œsophagoscope Sometimes there is considerable kinking of the œsophagus as it passes through the diaphragm owing to elongation and sagging-down of the lower segment to a level lower than that of the actual hiatus The diaphragmatic orifice is located by means of a fine gum-elastic bougie of Jackson s type. One or two larger sizes are then passed followed by a thin guide with a gum-elastic end introduced into the stomach a collapsed hydrostatic bag is then slipped down this guide (An instrument of this type is illustrated in Fig 724 p 1762) By this direct method wide dilatation may be obtained with a good result in most cases The bag can be dilated with water up to the size of four fingers

Expanding metal dilators of umbrella type used under direct vision have been passed through an œsophagoscope in our opinion dilating bags are preferable Stretching with a bag appears to have advantages also over the *thread-guide* method and the *fluoroscopically guided dilators* of Mosher

If the condition cannot be treated by one of the oral methods of dilatation, it will occasionally be necessary to carry out some operative interference. Patients who require this type of intervention are often in a poor state of nutrition and in these circumstances it is much wiser to perform a preliminary gastrostomy As a result not only does the general condition rapidly improve but the local obstructive lesion may also be ameliorated and after a time measures of dilatation from above which previously failed may be practised with success.

It is not usually convenient or practicable to clamp the œsophagus but a small opening should be made into the lumen in the first place so that any content may be removed by aspiration or by careful mopping the anastomotic opening should not be less than 1¼ in. long as there is a tendency to contraction If for any reason it is not practicable to draw up the stomach a loop of jejunum may be used.

It might be thought to be a good plan to cut across the œsophagus and to implant the proximal end into the stomach but if that is done the difficulty is to deal with the lower end of the œsophagus where secretion and débris may accumulate and cause leakage into the pleura or cellular tissue.

The mortality of these interventions has been high and life has only been prolonged for a matter of months but the preservation of the priceless comfort of the function of swallowing has been judged to be well worth while.

ŒSOPHAGECTASIA

ACHALASIA CARDIOSPASM PHRENOSPASM

There is as yet no standard method of treatment for this condition The proper management will probably depend on the causation which is not yet understood and the stage at which relief is sought.

Curative methods.—It should be recognized that some of the early cases can be cured by the use of intelligent and persistent dilatation by one of the methods in common use. At the Mayo Clinic great success has attended the use of the hydrostatic dilator (the Plummer Vinson dilator) as devised there nearly 50 years ago and used regularly ever since in thousands of cases. Negus and others have had notable success with the expansile bag passed through an œsophagoscope under the guidance of the eye and distended by water regulated by hand pressure.

The mercury bougie as advocated by Sir Arthur Hurst * has also proved valuable if used according to his precise directions. In many cases where it has said to have failed these directions have been much neglected. As the bougie has to be passed frequently and this may be difficult and painful it has largely fallen into disuse Retrograde digital dilatation through the open stomach (Mickulicz) is now obsolete, though of historic interest The residue of cases not permanently relieved by dilatation should not amount to more than about 8 per cent to 5 per cent and these will require some type of operation on the lower end of the œsophagus These methods include cardiotomy (Heller) cardioplasty or œsophago-gastrostomy they may prove satisfactory and lead to lasting cure

A great many other plans have been tried or are still on trial, but have not yet been sufficiently tested to be recommended Among the *palliative methods* the regular removal of stagnant œsophageal débris the self passage of weighted bougies and short-circuiting by

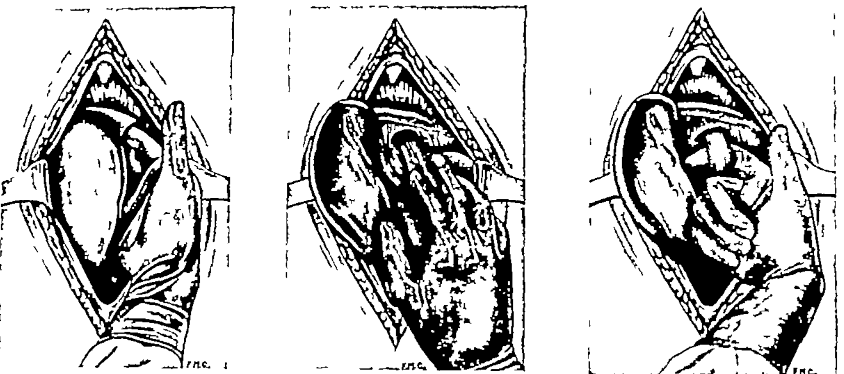


Fig. 740.—Exposure of lower end of oesophagus through an upper abdominal incision

A. The left lateral ligament of the liver before division. B. The ligament has been divided and the left lobe of the liver turned aside. Dotted line indicates site for incision of over-lying peritoneum. C. Oesophagus has been mobilized by the finger which is shown hooked behind it.

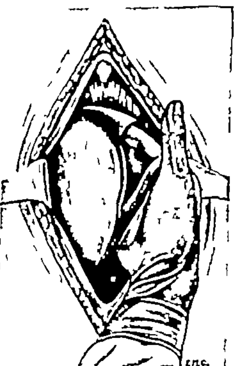
The surgical measures to be employed on the lower œsophagus may take the form of (1) digital dilatation or (2) some type of plastic operation

Digital dilatation of the lower end of the œsophagus (Mickulicz).—The abdomen must be opened and the stomach explored to exclude any lesion such as high lying gastric ulcer to which the œsophageal condition might be secondary The stomach is opened at some accessible part on its anterior wall not too far from the cardiac end The incision should be sufficiently large to admit the whole hand

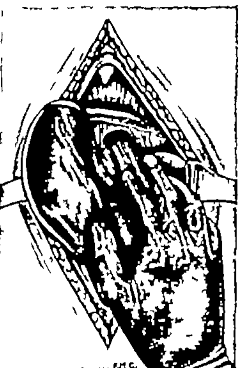
In order to avoid soiling the abdomen a wide purse-string suture should be placed round the opening in the stomach wall and loosely tied around the fingers or hand while the manipulations are in progress As a rule the first finger will enter the cardiac canal with comparative ease and if that is so eventually three fingers may be inserted like a cone and passed slowly and steadily up the œsophagus as far as the knuckles Since equally wide dilatation can be attained through the natural channels there is no indication to open the abdomen. This route was however previously in use

Plastic operations on lower œsophagus.—For these interventions an adequate exposure is essential. This requires a suitable parietal incision and mobilization of the left lobe of the liver In January 1918 Adrien Lambert an American surgeon published* a description of the method of exposing the lower end of the œsophagus by separating the left lobe of the liver from the diaphragm This method has been modified and often used by one of us (Grey Turner) and was described and illustrated in the Bigelow Lecture for 1931 † The operation is conducted under general anæsthesia with the patient in the reversed Trendelenburg position A long median incision is made commencing in the angle between the left border of the ensiform cartilage and the costal margin and carried down to or a little below the umbilicus The upward extension of this incision is the most important feature of this approach A long oblique incision parallel with and just below the left costal margin has also been recommended The next step is to take hold of the left lobe of the liver and to draw it downwards, thus exposing the left lateral ligament which is always very well defined and has an especially sharp left margin (Fig 740A) The ligament is divided with scissors along its centre and for its whole extent By this manœuvre the left lobe is completely mobilized and may then be either lifted out of the incision and held over to the right by a hand or some type of retractor or if not too bulky it can sometimes conveniently be packed under the right side of the abdominal wall where it can be held out of harm s way by a broad retractor The stomach is then drawn well downwards when an excellent view of the intra abdominal œsophagus covered by peritoneum will be obtained Using a syringe armed with a long fine needle about two

* Lambert, *Surg Gyn. Obst.*, Jan 1914.
† Grey Turner *New Eng Journ. Med.*, Oct. 1, 1931.



A



B



C

Fig 740 —Exposure of lower end of oesophagus through an upper abdominal incision

A. The left lateral ligament of the liver before division. B. The ligament has been divided and the left lobe of the liver turned aside. Dotted line indicates site for incision of over-lying peritoneum. C. Oesophagus has been mobilized by the finger which is shown hooked behind it.

ounces (60 c c.) of 1 per cent. novocain (procaine) is injected into the cellular tissue surrounding the lower end of the œsophagus. The overlying peritoneum is then divided transversely at the point where it is reflected from the diaphragm on to the œsophagus (Fig 740B) A vessel which is always found running across in front of the hiatus must be carefully avoided or ligatured. The finger can now be introduced into the diaphragmatic hiatus and can easily be worked around the œsophagus which can readily be separated from its cellular bed up to the highest point which the finger can reach With the finger hooked round the œsophagus quite firm traction can be safely made and it can usually be drawn down to an appreciable extent (Fig 740c) Unless it is elongated as the result of obstruction or is of the sinuous type it is not usually possible to expose more than 2 to 2½ in. in this way The lower œsophagus is now available for inspection and investigation After the necessary intervention has been carried out the left lobe of the liver is allowed to fall back into position and does not require to be fixed by suture though if necessary it may be attached to the diaphragm or the œsophagus by a stitch or two

Heller s operation —In its scope and plan this operation is strictly parallel with the Rammstedt operation for congenital hypertrophic stenosis of the pylorus The abdominal portion of the œsophagus is exposed and a vertical incision made along its anterior surface including the junctions with the stomach This incision must be at least 1½ in long or may be 3 in half of it must be situated on the œsophagus proper and the other half on the stomach wall The incision goes through both longitudinal and circular muscle fibres and is *deepened until the submucous bed is reached* The muscular fibres are then encouraged to retract by a little blunt dissection with the handle of the knife or gauze stripping The mucous membrane should freely bulge into the gap but is not to be opened. If the incision does not gape sufficiently the edges may be held wide apart by fixing the muscle to the limits of the exposed mucous membrane with a suture on each side opposite the centre of the incision In some cases the vertical incision becomes more or less diamond shape and it is only when this occurs that the operation is likely to be entirely successful.

Cardioplasty —In this operation a similar vertical incision is made through the junction between the œsophagus and stomach but the lumens of both viscera are freely opened The incision is then sutured in the opposite direction The interference is comparable with the operation of pyloroplasty and its principle is sufficiently indicated in Fig 741 The incision through the œsophageal wall should be from 1½ to 2 in long depending upon the size of the parts to be dealt with but whatever its length the centre should be at the situation *of the stenosis It is usually convenient to make* the incision in its entirety down to the mucous membrane and then to make a small opening through the latter at the lower end In this way any sudden

flooding of the parts with gastric or œsophageal contents can be avoided and what does escape can be removed with the suction apparatus or mopped up with gauze The mucous membrane is then divided throughout the whole length of the incision Some few vessels will have to be caught and ligatured

The closure is begun by suture of the mucous membrane The extremities of what was the vertical incision are first drawn together by an interrupted guide stitch and the closure is completed by continuous sutures commencing at either end and finishing up at the

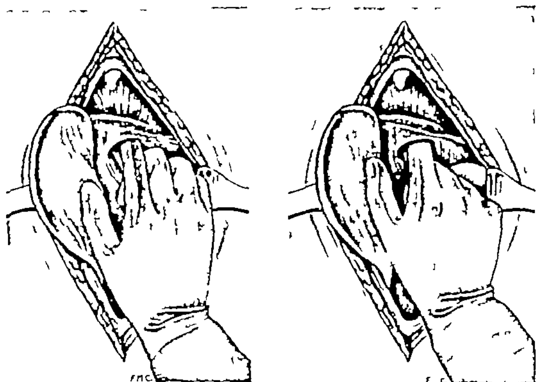


Fig 741 —Mobilization of lower part of œsophagus by finger working in the cellular tissue of the œsophageal tunnel. The finger can be introduced right up to its metacarpo-phalangeal joint

central guide stitch This suture should be hæmostatic and watertight The muscular walls are drawn together over the mucous membrane by a series of interrupted sutures These must go through both layers of muscles and must take a good bite and be very gently approximated and tied or they will probably cut out As a third series a few sutures are used to close up any gaps and to draw any loose tissue in the vicinity over the suture line Since better results are obtained with Heller s operation cardioplasty is not recommended

Short-circuiting œsophago-gastrostomy —It is seldom that this operation is required, since dilatation suffices for most cases and Heller s operation for all but a very small number of the remainder —

(*a*) **The operation from below the diaphragm.**—The œsophagus is exposed and mobilized as already described It is not easy to control the area of anastomosis with clamps and these are really not essential, but if the stomach is bulky or somewhat distended a clamp may be placed across the upper part in such a way as to shut off the area of anastomosis from the main portion of the viscus and to act as a tractor The left side of the œsophagus can now be approximated to the fundal

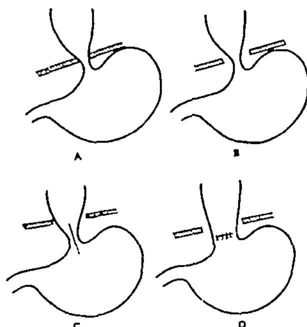


Fig 742.
A, B. Mobilization of lower end of œsophagus as in Fig. 741. C. Vertical incision through stricture. D. Incision sutured transversely showing consequent broadening of œsophagus.

end of the stomach as shown in Fig 748 As a first step in the anastomosis a posterior layer of interrupted or continuous sutures is applied between the bare muscular wall of the œsophagus and the peritoneum-covered stomach The wall of the œsophagus is very friable and stitches easily cut out and for that reason they must not be drawn tight easy approximation is all that is required The opening in the œsophagus is made obliquely or both it and the stomach may be incised after the manner of the Finney pyloroplasty It is usually *possible in the first case to incise the muscular walls of both* œsophagus and stomach without opening into the lumen of either and in that case the posterior muscular layers are approximated with a few interrupted sutures. The mucous membrane of the œsophagus is very lax and bulges between the edges of the cut muscle. In the first instance only a small opening is made. When the mucous membrane is incised an accumulation of fluid in the gullet may be very troublesome, and the surgeon must be prepared with the suction apparatus and

ample gauze protection A little gauze may be packed into the opening and left until the suture is nearly completed It is important to make the anastomotic opening of sufficient size and certainly not less than an inch and a half in length. The suture uniting the mucous membranes of the stomach and œsophagus must be continuous and of catgut and anteriorly it may include the deeper layer of the muscular coats The anterior external layer of sutures must also take a good hold of the muscle and is better interrupted It is important

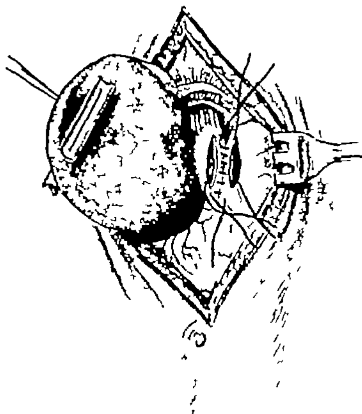


Fig 743 —Anastomosis of lower end of the œsophagus with the stomach.

that one or two additional stitches should be placed at either end beyond the anastomosis The left lobe of the liver is replaced in position and fixed to the stomach just below the anastomosis by a mattress stitch This not only protects the union by acting like a graft but is also a means of anchoring the mobilized lobe No special after treatment seems necessary Many of the cases have been operated upon after gastrostomy but this is certainly not essential If thought wise a Ryle s tube passed through the nose may be employed When there has been no tube the patients have been allowed to have sips of water from the first and if that can be swallowed without discomfort liquid nourishment is administered Otherwise for the

first few days rectal and intravenous alimentation can be used. Leakage with subdiaphragmatic abscess is the complication most to be feared

(*b*) **Operation by the thoracic route.**—This operation was first carried out through the chest and this route may be necessary when for instance it is proposed to make the union between a diverticulum of the thoracic œsophagus and the cardiac end of the stomach or it may be selected for ease of access The preliminary stages are the same as for trans-thoracic œsophagectomy

The œsophagus is readily exposed below the root of the lung by dividing the overlying pleura, and may be separated from the cellular tissue with the finger If the œsophagus is much dilated or if there is a diverticulum it is better not to separate the whole œsophagus from its bed but merely to expose the part that is to be used for the anastomosis The area can be demarcated by inserting a couple of guide sutures The fundus of the stomach is then exposed by incising the diaphragm through its summit commencing the incision about an inch and a half in front of and external to the hiatus and making it about 2 in in length A cone of stomach as free from vessels as possible is then drawn up and may be grasped by a curved stomach clamp Sometimes such a clamp can be applied to the portion of the œsophagus selected for the anastomosis but this is not essential. Steps must be taken to prevent flooding of the operation area with œsophageal contents

Before sutures are inserted the pleura should be protected from contamination by gauze soaked in 1 1 000 acriflavine. The next step is to approximate the œsophagus and the cone of stomach and to suture them together by a posterior Lembert suture This stitch has often to be interrupted because of the friability of the œsophageal wall The opening into the lumen should be 1½ in in extent It is wise to make only a very small incision into the lumen to begin with so that escaping contents can be controlled by the suction apparatus. The main approximation is made with a continuous suture through all the coats Great care should be taken to protect this with further interrupted sutures passed between the muscular wall of œsophagus and stomach With the final protecting stitch the mediastinal pleura may be tacked to the œsophagus the same stitch catching up the peritoneal coat of the stomach If the cellular tissue has been soiled it should be smeared with one of the sulpha group antiseptic powders If the opening in the diaphragm is obviously too free there is a risk of hernia and it should be diminished by sutures at the extremities but care must be taken not to constrict the stomach cone. The base of the cone should be attached to the edge of the incision in the diaphragm The surgeon must use his judgment as to whether he leaves a drain in the pleural cavity

Results.—While these operations can be carried out with a very low mortality and usually most encouraging immediate success and many

listing ones the results are sometimes uncertain and unsatisfactory Heller's method of cardiotomy seems to have been followed by the fewest disappointments * In persistent recurrent cases resection of the lower third of the œsophagus and the acid bearing portion of the stomach has been recommended †

ŒSOPHAGEAL VARIX

This condition is usually the result of cirrhosis of the liver or one of the phenomena associated with splenic anæmia. Œsophageal hæmorrhage may recur after splenectomy and deaths from this cause have occurred after this operation Some cases of varix have been treated by coagulating injections or diathermic coagulation carried out through the œsophagoscope In other cases the left coronary vessels have been ligatured with arrest of hæmorrhage and it is said without recurrence but it must be admitted that all these methods have often failed. Of late porto-caval shunts have been made and the lower œsophagus with the cardia has actually been resected. The latest plan to be tried out is splenectomy devascularization of the lower part of the œsophagus and the cardia of the stomach bilateral vagotomy and gastro-enterostomy ‡ Though perhaps rational in conception this intervention may be rather a severe ordeal

ŒSOPHAGO-TRACHEAL OR BRONCHIAL FISTULA

When this condition is the result of malignant disease in the cervical œsophagus it may on some rare occasions be so localized as to justify an attempt at excision of the parts involved As a general rule it is only in non malignant conditions that operative interference may be considered When the condition results from an abscess or the long standing impaction of a foreign body healing may follow the removal of the cause though it may be a slow process Sometimes the rest provided by gastrostomy assists spontaneous closure In operative interference the principles that must guide the surgeon are first the necessity of separating the two structures so that they may be independently repaired and secondly the provision of physiological rest during the process of healing by temporary gastrostomy

In the neck the area may be approached as already described (p 1754) for the operation of œsophagotomy When situated in the thoracic œsophagus the trans-thoracic route will have to be followed. During the process of separation the communicating aperture may be torn much larger If the edges are indurated they should be excised. In closing the aperture in the œsophagus the sutures must be inserted across the lumen and not in its length in order to avoid narrowing Any soft tissue in the vicinity should be drawn over the area to fortify the suture line A whole-thickness skin graft has been employed

* Barrett and Franklin *Brit Journ Surg* 1949 xxxvii, 1941
† Wormach *et al* *Journ Amer Med Ass* Feb. 3, 1951 cxlv No. 5.
‡ Gray and Whitwell, *Ann* *S* Oct 1951, cxxxiii, 799-810.

and from behind by those of the styloglossus the thickness of the organ rapidly increases and in its middle third reaches 3 or 4 cm. before it diminishes again towards the tip The thick part of the tongue extends only about ¾ cm to either side of the midline followed laterally beyond this the extent of the organ is no greater than that appreciated from within the mouth

The rest of the floor of the mouth is occupied by the submaxillary and sublingual salivary glands the mylohyoid and digastric muscles and the submental and submaxillary lymph glands Posteriorly the digastric muscle and the submaxillary salivary gland are in contact with the carotid sheath and at this point there is no clear division between the structures of the floor of the mouth and those of the carotid triangle of the neck. Wharton s duct and the lingual nerve lie immediately beneath the mucosa of the floor of the mouth as they pass forward on the lateral surface of the hyoglossus. Posterior to the molar teeth the lingual nerve lies above the submaxillary duct and to its lateral side At the anterior border of the hyoglossus the nerve hooks round below the duct and passes forward to the side of the tongue just beneath the mucosa.

Blood supply —The structures of the mouth are normally supplied almost entirely by branches of the external carotid artery and, if preliminary control of the circulation is required ligature of the external carotid is the best method. In dealing with vascular tumours it must be remembered that abnormal anastomoses have usually been established and ligature of the main vessel to a tumour may not diminish its circulation materially If a temporary diminution takes place circulation often re-establishes itself completely in a very short time and such procedures as ligature of the labial artery or arteries as a method of treatment for angioma of the lip are very unlikely to be successful. In very vascular tumours such as cirsoid aneurysms ligature of both external carotids may fail completely to control the bleeding owing to the extensive anastomoses which have been established with the vertebral artery

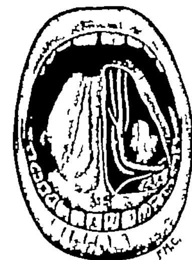


Fig 745 —Course of the lingual artery

The course of the lingual artery in the substance of the tongue is of some importance to the surgeon (Fig 745) as he may wish to secure it when performing an intrabuccal excision After it emerges from beneath the hyoglossus it runs close to the mucous membrane of the under surface of the tongue parallel to the frænum and close to it. Owing to its tortuous course it can often be seen and secured before

it is divided particularly if traction is being made on the anterior part of the tongue. Some part of the blood supply of the posterior part of the tongue is derived from the facial artery and ligature of the lingual anywhere in its course does not completely control hæmorrhage in operations involving the posterior third The classical operation of ligature of the lingual artery beneath the hyoglossus has no practical application

There is no free vascular anastomosis across the middle line of the tongue and once the correct plane is found the tongue can be split from its tip to the epiglottis with very little bleeding

The facial artery shortly after it leaves the external carotid comes into intimate connection with the submaxillary salivary gland and operations which involve the removal of the gland generally require division of the artery

Nerve supply Sensory —The chief sensory nerves in the mouth are the trigeminal and the chorda tympani which joins its lingual branch. In addition the glossopharyngeal nerve supplies the pharynx and posterior part of the tongue for both taste and ordinary sensation The lingual nerve may be anæsthetized by infiltrating the tissues below and posterior to the last molar tooth where the nerve lies just under the mucosa. A little further forward where it lies on the lateral surface of the hyoglossus the nerve is connected to the submaxillary gland by the fibres which it sends to the submaxillary ganglion When the tissues are inflamed and œdematous the lingual nerve may be difficult to define and in removing an inflamed submaxillary gland it is easy to pull down the lingual nerve with the gland and injure it Division of the lingual nerve is a serious matter as it produces anæsthesia of one side of the tongue exposing it to the risk of repeated and unnoticed injuries

Motor —The motor branch of the fifth nerve supplies the muscles of mastication The tongue is supplied by the hypoglossal and the muscles of the pharynx and soft palate by the bulbar part of the accessory nerve through the vagus

Lymphatics of the mouth. The tongue —The lymphatics of the tongue consist of a submucous plexus continuous over the whole surface and communicating with an extensive intramuscular plexus The collecting vessels of the central part of the tongue may often be observed to cross the midline and drain into the glands of the opposite side of the neck It is reasonable to suppose that this tendency to drain into the glands of the opposite side is increased where the lymphatic vessels of one side have been obstructed by growth or removed by operation

There are three main groups of glands which receive lymph from the tongue (1) The submental group which lies between the anterior bellies of the digastric muscles between the hyoid and the jaw (2) The submaxillary group which lies in close relation to the submaxillary

salivary gland and the facial vessels It is important to note that one at least of these glands may be on the superficial surface of the jaw just in front of the masseter and close to the facial artery Failure to appreciate this fact may lead to this gland being left untreated and a potential source of recurrence (8) The deep cervical group lying along the internal jugular vein beneath behind and in front of the sterno-mastoid Two sub-divisions of this group are of special importance the jugulo-digastric group and the jugulo-omohyoid group The former as its name suggests lies between the posterior belly of the digastric and the jugular vein and includes one large gland

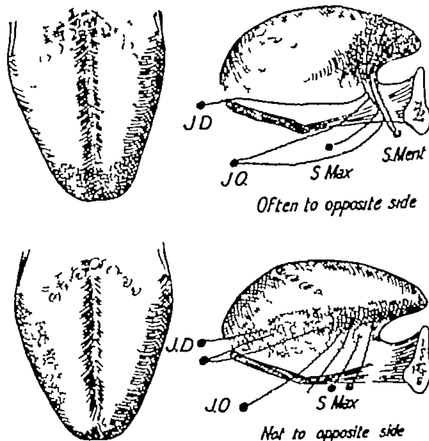


Fig 746 —Lymphatic drainage of tongue, tip and frenal region and lateral margin.

which is very often affected in carcinoma of the tongue and has been called the principal lymph-gland of the tongue. The jugulo-omohyoid gland is situated on the vein at the point where the omohyoid crosses it It receives lymph indirectly from all parts of the tongue and some lymphatic vessels run directly to it It may therefore be involved early and it is of particular surgical importance because it is near the lower limit of the usual operation for the removal of malignant glands.

The tongue may be divided into four areas for purposes of describing its lymphatic drainage —

(1) The tip and frænal region.

(2) The lateral margin
(3) The central area
(4) The pharyngeal part

Reference to Figs 746 and 747 will show how the drainage from those areas passes to the various groups of glands All three glandular groups receive lymph from all parts of the tongue except the area behind the circumvalleate papillæ which apparently drains exclusively into the deep cervical glands The vessels draining the tip and frenal

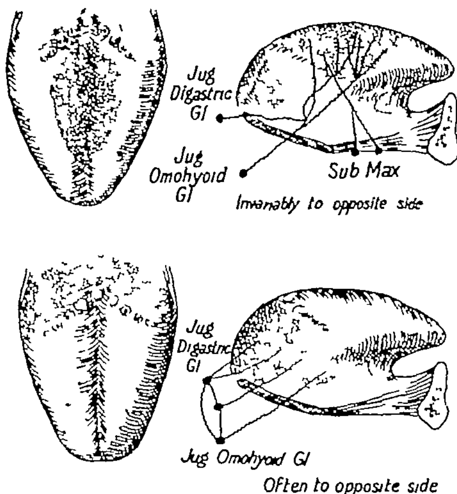


Fig 747 —Lymphatic drainage of tongue central and pharyngeal portions.

region pass very close to the periosteum of the jaw on their way to the submental or submaxillary group and operations for the removal of infiltrated glands in this area may fail unless particular attention is paid to this point The efferents of the submental glands pass indiscriminately to the submaxillary and jugulo-digastric groups of either side thus a growth at the tip of the tongue may easily give rise to bilateral glandular metastases There is no fixed line of division between the lateral and central drainage areas but injection at a point a third of the way from the lateral margin to the middle line usually fills some of the central vessels so it is clear that there are few growths

which may not involve the lymphatics of the central area. This is important as many of the collecting vessels of this area cross the middle line to end in the glands of the opposite side of the neck. The drainage of the pharyngeal part (i e that part of the tongue behind *the circumvalleate papillæ) is said to run exclusively backwards* into the deep cervical glands sometimes crossing the middle line. Clinically however secondary growth is often observed in the submaxillary lymph glands when the primary growth is in the pharyngeal part of the tongue

It must be emphasized that the glands of the deep cervical group receive much of the drainage of the tongue direct and consequently may be infiltrated before those of the submaxillary and submental groups. It must also be remembered in planning the method of attack on a growth of the tongue that the lymphatics of the genio-hyo-glossi may be infiltrated and any method of treatment directed solely to the buccal part of the tongue may leave active growth in the lymphatics of the deeper muscles

The buccal cavity —Two more groups of glands must be considered in conjunction with the lymphatic drainage of the rest of the buccal cavity The parotid lymph glands which lie in the substance of the parotid salivary gland receive some of the lymph from the posterior part of the gum. They may be involved as a result of growths in this situation but fortunately such involvement is not common Lymph glands also lie in relation to the internal maxillary artery and it is probable that growths which infiltrate the pterygoid region also affect these glands Their efferents pass to the deep cervical glands and involvement of this group in a faucial growth suggests that the internal maxillary group is also affected.

Apart from these two groups the lymphatic drainage of the mouth is comparable with that of the tongue Carcinoma of the floor of the mouth if situated anteriorly may give bilateral metastases and direct involvement of the jugulo-omohyoid group sometimes occurs. In growths of the cheeks and upper lip spread is mainly downwards in the line of the facial vein and involvement of the parotid group is not common. Carcinoma of the central part of the lower lip is likely to affect the submental glands while growths in the lateral part usually miss the submental group and pass direct to the submaxillary region or to the glands of the deep cervical chain.

Lymphatic channels enter the mandible through the mental foramen in some cases and it is probable that these lymphatics are responsible for the occasional occurrence of secondary deposits in the substance of the mandible when the primary growth is in the anterior part of the mouth or the lip

OPERATIONS FOR NON-MALIGNANT CONDITIONS OF THE MOUTH AND TONGUE

Congenital and Developmental Abnormalities

Hare lip and cleft palate.—These conditions are dealt with on p 1919

Macroglossia.—True macroglossia as opposed to the much commoner lymphangiomatous enlargement is usually found in mentally deficient children Treatment may be required if the tongue is large enough to make feeding difficult and the best operation is excision of a wedge of the whole thickness of the tongue including the tip The operation presents no special difficulties but children suffering from this condition tolerate operative interference badly and may lose their lives as a result of post-operative complications Arrest of hæmorrhage is important. Vessels that can be seen must be caught before division and ligatured. Bleeding from smaller vessels and oozing is arrested by careful approximation with sutures passed through the whole thickness of the tongue.

Abnormalities of the frænum.—Tongue tie or undue shortening of the frænum although rare is occasionally seen. The operation of division of the frænum was at one time frequently performed in the belief that a short frænum delayed the ability to talk This is not so and the operation is not free from danger as many fatalities are on record both from hæmorrhage and from suffocation due to dropping back of the tongue Division of the frænum should not be practised in newly born children If performed later it is safe and perfectly simple but the tongue should not be stripped up from the floor of the mouth and an attempt should be made to secure primary union of the mucous membrane otherwise the resultant scarring may leave the patient in a worse position than before

Sublingual dermoids.—These tumours may reach a large size before the patient seeks advice. They are best approached by an external incision between the mandible and the hyoid bone A vertical incision is made in the middle line from the point of the jaw to the hyoid bone and the mylohyoid muscles are separated in the midline exposing the cyst wall. The cyst can generally be separated easily from its surroundings by blunt dissection through this incision If the dissection is difficult a better exposure can be obtained by dividing the mylohyoid muscles transversely close to the hyoid bone If the wall of the cyst is accidentally ruptured the operator must make sure that the whole of the epithelial lining is removed as otherwise a sinus will persist and necessitate a second operation It is often difficult to dissect out the larger cysts entire but if they are torn it is a good plan to put a finger inside to act as a guide to their deep connections Removal of a sinus whether it results from spontaneous infection or from inadequate surgical treatment is much more difficult The operation consists in complete removal of the track from among the muscles of the floor of the mouth Provided that no part of the epithelium lining the track is left behind this operation gives good results but it is tedious and difficult to perform owing to the inaccessibility of the region and the vascularity of the surrounding tissues

Ranulæ.—These tumours appear to be situated superficially under the mucous membrane to one side of the frænum of the tongue but

they spread deeply and irregularly among the muscles between the jaw and the hyoid Attempts to remove them intact are seldom successful but it is often possible after the cyst has been punctured to remove the whole of the epithelial lining by careful dissection and gentle traction It is advisable to use diathermy for the original incision through the mucosa and for dividing the bands of tissue which attach the cyst wall to its surroundings as this ensures a relatively dry field and makes it much easier to see the lining membrane of the cyst clearly Alternatively the operator may satisfy himself with the following procedure The cyst is opened widely by removing a disc of its superficial wall and the mucosa which overlies it and the sticky mucous contents are removed This is best done by entangling the mucus in pledglets of dry gauze held in forceps The wall is then scrubbed with a very small mop soaked in pure carbolic acid to destroy the epithelial lining and the resulting cavity is temporarily packed with gauze which may be fixed in position by a few catgut sutures The pack is removed on the following day and the wound heals rapidly by granulation The results of either of these operations are very satisfactory and the more elaborate methods which have been recommended to ensure complete excision of the wall are unnecessary

Thyroid rests at the base of the tongue.—Tumours composed of thyroid tissue occur rarely in the base of the tongue They may give rise to symptoms purely as a result of their size and they sometimes ulcerate and cause severe hæmorrhage Some of these tumours are malignant Wapshaw* makes the observation that in the series collected by him the patients in whom malignancy was proved were middle-aged men and that no true cases of malignancy occurred in young women Removal of thyroid tumours from the base of the tongue may cause myxœdema as the presence of the tumour may be an indication that the thyroid has failed to develop in its normal situation.

It is often stated that these tumours should be removed through the mouth but the tumours lie deep in the substance of the posterior third of the tongue and are very vascular Thus removal through the mouth is technically difficult and may well be incomplete. Performed through the neck the operation is not unduly difficult. Wapshaw recommends a transverse incision above the hyoid bone followed by division of the hyoid bone to allow the muscles of the tongue to be separated in the midline and retracted to either side Some care and deliberation is required in separating the posterior surface of the hyoid bone from the underlying tissues especially at its upper border to which the thyrohyoid membrane is attached A more satisfactory procedure is to remove the body of the hyoid bone leaving the cornua in position The hyoid can be cleared of its muscle attachments most easily by using diathermy and working very close to the bone.

With this approach it is possible to commence the operation by exploring the lower part of the neck to ascertain whether a normal

* Brit Journ. Surg 1942, XXX, 160.

thyroid gland is present or not and it is also possible in case of necessity to extend the incision laterally to one or both sides to expose the external carotid artery and its branches

Trotter s method of median division of the tongue (p 1844) may be used for large tumours

The thyroid may develop at any position in the neck between the foramen cæcum and the normal position of the thyroid. Thus a solid tumour in the position usually occupied by a thyroglossal cyst may represent the whole of the functioning thyroid tissue In pre-operative investigation of these cases tracer doses of radio-active isotopes are very useful Ectopic thyroid tissue in tongue or neck rarely shows the structure of normal thyroid and if the tumour which arises from the presence of thyroid tissue in an abnormal position gives rises to symptoms it is better to remove it and employ replacement therapy with oral administration of thyroid extract if it is necessary

Acute Inflammatory Conditions

Lingual abscess.—This may be a complication of a retained foreign body or occasionally a sequel of acute superficial glossitis It is best opened by a longitudinal incision and if the tongue is greatly swollen a preliminary tracheotomy should be done under local anæsthesia. Through this tracheotomy general anæsthesia can be administered and the pharynx packed in order to prevent aspiration of pus into the respiratory passages If the abscess is in the front of the tongue the patient can be anæsthetized in the ordinary way With the patient on the side and the back of the mouth packed lightly with gauze there is little risk during the short period which is necessary for incision and evacuation of the pus

Ludwig's angina—Operative treatment is to evacuate the pus as soon as its presence can be diagnosed. The disease appears to originate as a cellulitis in the tissues deep to the mylohyoid. External signs of softening are late in appearing but if incisions are made into the brawny swelling beneath the jaw a day or two after the onset of the disease it is usually possible to discover and evacuate an abscess cavity A full general anæsthetic is necessary and the first incision should run from the hyoid to the point of the jaw keeping strictly to the mid line so as to avoid excessive hæmorrhage The incision is then deepened through the mylohyoid and if pus is not discovered at once a pair of blunt forceps should be passed deep to the mylohyoid in the direction of the molar teeth on one or other side Once the abscess cavity has been discovered counter incisions may be made This disease often occurs in debilitated patients and in them the mortality is high

Attempts to deal with this condition under gas anæsthesia are very dangerous as œdema of the glottis may occur very suddenly

Note The introduction of chemotherapy has made both the above conditions very rare in countries in which medical attention and adequate treatment are readily obtainable

Cancrum oris.—This disease is fortunately rare under present-day conditions If conservative treatment fails the best chance of saving the patient s life is to excise the gangrenous area without regard to subsequent deformity Excision by diathermy is preferable and the incision should be made outside the area in which the vessels are thrombosed Some necrosis of the jaw may be expected. A long interval must be allowed before any attempt is made to close the resulting defect and during this time the patient should be taught to use a wooden wedge between the teeth to prevent trismus

CHRONIC INFLAMMATORY CONDITIONS

Leucoplakia of the lips.—Patches of thickened epithelium on the lips are occasionally encountered in elderly men some of whom have already suffered from an epithelioma in another part of the lip and such lesions are probably a pre-carcinomatous change. Their disappearance can often be secured by superficial irradiation with X rays or unscreened radium a treatment which lasts only a few hours and does not necessitate confinement to bed. Lesions which resist this treatment should be excised The deformity which results even from excision of large areas is surprisingly slight if repair is carried out with care

Chronic superficial glossitis and leucoplakia in the tongue.—In cases of chronic superficial glossitis it may be necessary to excise a localized patch of diseased epithelium for biopsy If the area to be excised is sharply localized and surrounded by normal tissue knife excision is superior to diathermy as the chances of primary healing after suture are higher When the whole tongue is affected with chronic superficial glossitis the chances of primary union are poor in any case and it is better to excise the suspected area with diathermy as this leaves a softer scar and also makes the technical steps somewhat easier

Established chronic superficial glossitis is difficult to treat. Irradiation has been employed but is not satisfactory and Berven* states that the dose of irradiation necessary for the cure of the condition is so large that there is grave danger of damaging normal tissue. Localized patches of glossitis with leucoplakia are best treated by diathermy coagulation to the depth of a few millimetres This produces a slough which takes some weeks to separate but the scar which results is generally soft and pliable

Cases in which larger areas of the tongue are affected should be watched for a time In many of them the changes progress very slowly and provided that they are kept under regular observation active treatment is unnecessary Where the change appears to be progressive and particularly if cracks and hard excrescences appear the affected epithelium must be excised together with enough underlying tissue to ensure that the indurated avascular tissue which lies beneath is removed.

* Acta Radiol 1929, X, 2.

Many operations have been devised for this purpose It is un necessary to quote them in detail as the type of operation required varies with the situation and extent of the epithelial change The operator need only remember that any operation which leaves the intra-oral part of the tongue mobile and one-half or more of its normal size leaves little ultimate disability It matters little whether the denuded area of tongue is covered by turning the tip of the tongue backwards or by turning the lateral border towards the midline or by a combination of these methods Patients in whom the tip of the tongue has been removed or fixed sometimes complain of dribbling

Ulcers of the Tongue and Mouth

Excision of ulcers in the tongue is best performed with adequate general or regional anæsthesia. Local anæsthetics are less suitable as the œdema which they produce makes it more difficult for the operator to be certain of the limits of the disease. The tongue should be drawn out and exposed by several tractor stitches so that the ulcer and the surrounding tissues are fully exposed. Diathermy is con venient as it reduces the amount of bleeding and may in tuberculous ulcers reduce the likelihood of re-infection of the wound but it is open to the objection that a large proportion of diathermy wounds fail to heal by first intention Thus knife excision is better when the ulcer is small and primary healing is desired

Simple or traumatic ulcers.—Ulcers which are thought to belong to this class should always be excised if they fail to react to con-servative treatment within a week or two Since biopsy is the main object of the excision it must extend widely enough into the sur rounding normal tissue to ensure a satisfactory microscopic section (*see* p 1885) Carcinomatous ulcers of the lower alveolus may present none of the ordinary physical signs of malignancy and early biopsy in this situation is of special importance

Tuberculous ulcers.—Tuberculous ulcers of the tongue complicating advanced pulmonary disease are generally regarded as unsuitable for surgical treatment though Butlin stated that if they are not very extensive they may be removed to the great relief of the patient.' Tuberculous infection of the resulting wound is difficult to avoid and if it occurs the patient is undoubtedly worse off for his treatment. When ulcers are multiple operative removal should never be attempted

Tuberculosis of the tongue occasionally occurs as an isolated mani festation and in this case excision is the correct treatment but must be wide if it is to be successful and in fissured ulcers which are often very much deeper than they appear to casual observation the operator must take particular care that his excision of the deeper parts of the ulcer is complete

Innocent Tumours

Papillomata.—These should always be removed and unless they are very obviously innocent a wedge of the underlying muscle should be

taken so that the absence of infiltration can be demonstrated microscopically Radium has no real advantage over excision and has the disadvantage that it does not afford the opportunity for biopsy

Cavernous nævi in the lips and mouth as elsewhere consist of varying proportions of fat and vessels When they attain a large size they are very troublesome to deal with and if they are seen when small they should not be neglected

Small well localized tumours should be excised and even when they are soft and very vascular the operation is not unduly difficult as the large blood supply often comes from one or two dilated vessels which are readily picked up

Large diffuse tumours are very difficult to deal with They often present after previous unsuccessful attempts at treatment and may in this case be complicated by the presence of trophic changes in the overlying skin External irradiation is not suitable for cavernous angiomata though it produces good results in superficial nævi. Interstitial irradiation is sometimes used and may produce a diminution in the size of the tumour by virtue of the fibrosis which it induces. It is difficult to apply without causing excessive bleeding and if radium needles are used there is some danger of producing radium burns by allowing the ends of the needles to protrude through the holes into which they were inserted.

The methods commonly in use are as follows —

(1) Ligature of the main supplying vessels
(2) Excision
(3) Injection of saline.
(4) Injection of boiling water
(5) Interstitial irradiation followed by excision of the residual mass

Ligature of main supplying vessels is very unlikely to be successful *if employed alone but may be useful if it is employed together* with injection. In tumours of the lip it is often possible to feel a large dilated vessel approaching the tumour on each side but if these vessels are ligatured without employing any direct treatment to the tumour itself a collateral circulation is very rapidly established and no benefit results

Excision.—Tumours which are small and well localized should be excised without any preliminary treatment Attempts at excising large diffuse tumours should be avoided as complete excision is seldom feasible and early recurrence is likely Excision may be necessary following treatment by injection to remove a residual fibrous mass or as a preliminary to skin grafting designed to abolish the skin changes which cannot be removed by injection

Injection with saline—The technique of this method is simple and it is well spoken of by those who have used it A saturated solution of salt is used and injections are made at 4 or 5 points at a time in the

substance of the tumour injecting about ¼ c c of solution at each point It is very important to make the injection in the substance of the tumour and not immediately beneath the skin or mucosa as superficial injections may cause extensive sloughing

It may be necessary to repeat the treatment on several occasions In successful cases the soft pulsating tumour is replaced by a tough fibrous lump but the dilated vessels in the skin are unaffected and if they are extensive a subsequent plastic operation may be necessary

Injection of boiling water—This method has not been very widely used because of its technical difficulties and the fear of complications but those who have used it believe it to be very effective The method is well described by Cole and Hunt * The technique is described in detail in their article and the essentials are as follows —

1 The syringe This must be of pyrex glass covered with rubber at the point where the operator is to hold it and the junction between the syringe and the needle must either be of a screw type or else must be covered with a close fitting rubber tube in order to avoid the danger of blowing off the needle and producing scalds

2. The skin through which the injection is to be made must be covered with petroleum jelly to prevent scalds by leakage back through the needle puncture.

3 Ordinary tap water as near boiling point as can be achieved should be used

4 The aim is to inject into the tissue spaces without allowing the injection to approach close enough to the skin or mucosa to produce sloughing Cole and Hunt state that they have injected amounts varying from a few minims up to 75 c c on a single occasion They recommend that the skin or mucosa shall be carefully watched for blanching during the course of the injection Immediate increase in the size and tenseness of the tumour is taken to mean that the injection is correctly sited in the tissue spaces but further injection should be withheld in the presence of quick and rapid distension or when the tissues undergo a squirming contracture.

Cole and Hunt state that following this treatment bleeding is easily controlled and pain is insignificant Immediate swelling is sufficient in some cases to be alarming but subsides spontaneously Embolism has not occurred in their experience but skin sloughing is a serious complication and may lead to secondary hæmorrhage After the tumour has been apparently cured recurrences may appear over a period of years and patients should not be allowed to escape subsequent observation

Interstitial irradiation followed by excision.—Very good results are sometimes obtained by this method. The initial dose of irradiation should be small (2 000 to 3 000 r) and the tumour should be watched as long as it continues to diminish in size This diminution may continue for as long as 2 years The residual mass is then excised.

* Brit. Journ. Surg. 1948-49 XXXVI 344.

Lymphangiomata.—These tumours occur in the tongue lip and cheek Generally they do not appear as localized tumours but as a diffuse enlargement of the affected tissues and they are generally associated with some degree of vascular dilatation They grow slowly but certainly and should therefore be treated as soon as opportunity arises If the tumour is localized to one part of the tongue or lip it is best to attempt a radical excision though this is difficult owing to the complete lack of encapsulation Even when the tumour is very large and diffuse excision of large masses of redundant tissue is quite feasible and produces an improvement in appearance and function which may last for many years In excisions of this type hæmorrhage is considerable but is controllable

The place of irradiation in treatment of lymph angiomata is doubtful. External irradiation produces little or no improvement but interstitial irradiation generally makes the tumour smaller and harder and appears to reduce the liability to recurrent hæmorrhages which are sometimes a serious feature in lymphangiomata of the mouth In cases which are unsuitable for excision interstitial irradiation should be tried, using a dose not more than half that suitable for an epithelioma. Tumours which have been thus treated continue to diminish in size often over a period of years but they do not disappear and it is best to keep the patient under observation if the residual fibrous mass tends again to increase in size it should be excised

Mixed tumours.—Tumours having the structure and physical signs of a mixed salivary tumour are sometimes found on the palate or the inner surface of the lips and cheek They are usually very easily shelled out and do not normally tend to recur but occasionally even in children mixed tumours of doubtful origin recur and may metastasize

MALIGNANT DISEASE OF THE MOUTH AND TONGUE

Growths in this group differ greatly from one another in their clinical characteristics their reaction to treatment and their ultimate prognosis. It is therefore impossible to treat them as a single class and it has been thought better to consider first general principles and the available means of treatment and secondly their application to growths in various sites It must be remembered that treatment must be varied not only according to the type and anatomical situation of the growth but also according to its stage. Surgical treatment in carcinoma of the mouth at the present day is not concerned solely with eradication of the disease in operable cases. There are cases in which the ultimate prognosis is so nearly hopeless that an attempt at radical removal by operation or irradiation exposes the patient to suffering which is quite disproportionate to his chance of cure. Some of these cases can be made comparatively comfortable for a time by palliative measures and the possibilities in this direction are reflected in the

increasing proportion of cases which are considered suitable for treat ment It is therefore essential for the surgeon to have in his mind at the outset a clear idea of the stage of the growth he is about to treat as well as the degree and type of its extensions and something of the probable outlook. If he neglects this precaution he is likely to become involved in an operation or irradiation which starts as a radical treatment and finishes as a palliative one The results of such procedures are disastrous and they should be remembered by the surgeon who is tempted to throw aside all other considerations in his attempt to extirpate the growth Thus it may happen that the interests of the patient are best served by extending the field of treatment in early cases and contracting it in extensive ones

General Principles of Treatment

The ideal treatment for carcinoma in the mouth as elsewhere is an operation of the type of the Halsted excision of the breast that is to say removal in one block of the primary growth with a wide margin of apparently normal tissue the lymphatic areas concerned and the intervening tissues If this were possible the surgeon could approach early cases of carcinoma in the mouth with as much confidence as he can those in the breast Unfortunately such an operation is im possible in the mouth as the margin of normal tissue which can be removed without encroaching on essential structures is extremely small. Excision of the primary growth and the affected glands in continuity throws open the planes of the neck to infection from the mouth and although the dangers of infection are now much less than they were before the days of chemotherapy and antibiotics operations planned on these lines are still a difficult undertaking for surgeons with no special experience and slow healing with fistula formation is still fairly common

To a certain extent the difficulties may be overcome by the use of irradiation in the place of operation as essential structures which cannot be removed can mostly be irradiated sufficiently to destroy carcinoma cells which are present and irradiation can be made con tinuous from the primary growth to the limit of the metastases For these reasons surgeons who are familiar with both methods may choose to make use of irradiation where the primary lesion cannot be clearly separated from the secondary glands Unfortunately the advantages of irradiation are offset by the fact that, when growths in the pharynx are in continuity with glandular mestastases there is generally in filtration of cartilage and when similar conditions obtain in the mouth the bone of the lower jaw is affected Irradiation seldom eradicates growth which has infiltrated bone or cartilage and if there is evidence that bone or cartilage is invaded operation is preferable even when the operative risk is high

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If there is no evidence of direct continuity between the primary growth and the glandular areas most surgeons at the present time prefer to regard the treatment of the primary growth and that of the

glandular areas as two separate problems. Although this is unsatisfactory in theory experience has proved that recurrence when it does take place is nearly always in the site of the primary growth or in the glandular areas and only exceptionally in the intervening tissues.

The principles of treatment applicable to all growths in the mouth may be summarized as follows —

(1) **If the primary growth affects soft parts only and its situation allows excision with a margin of one third of an inch or more of apparently normal tissue,** it matters little whether irradiation or excision be used in its treatment Irradiation when correctly applied has the advantage that the primary mortality is negligible and the ultimate deformity slight but minor errors in the technique may produce disastrous results.

(2) **If a primary growth in soft tissues cannot be removed with an adequate margin** because of the proximity of essential organs irradiation is preferable to an incomplete operation Growths which show signs of rapid dissemination by early and widespread involvement of lymph glands are also better treated by irradiation In most cases in which distant metastases are present irradiation is preferable as it imposes less strain on a patient whose period of survival is limited by the presence of remote metastases

(3) **Certain cases in which the primary growth is known to be highly radiosensitive,** such as infiltrating tumours of the upper jaw and posterior third of the tongue should always be treated by irradiation in whatever stage of their development they are seen These growths are most unsuitable for operation and irradiation generally secures their rapid disappearance.

(4) **If the regional lymph nodes are invaded and cannot be clearly separated from the primary growth,** treatment by irradiation is capable of producing good palliative results unless the growth infiltrates bone or cartilage. Operation carries a higher mortality but produces more cures. Invaded glands which are not in direct continuity with the primary growth should be treated separately

(5) **Growths which infiltrate compact bone** such as the lower jaw are unsuitable for irradiation Excision is nearly always worth trying and sometimes gives very good results

(6) **Growths which have been treated primarily by irradiation and have remained uncured** should be treated by operation provided that they are within the limits of technical operability Under present conditions such growths form a considerable proportion of those presenting themselves for treatment to surgeons It is to be hoped that radiotherapists generally will in time accept that growth persisting or recurring in an area which has already been adequately irradiated is in most cases an indication for surgery A single adequate irradiation increases the difficulties of operation very little but tissues which

have been pushed to the limit of viability by repeated irradiation and are still infiltrated with growth are very difficult to deal with

(7) **Growths occurring in a mouth which shows widespread leucoplakia** with sub-epithelial fibrosis are generally unsuitable for irradiation The prospects of cure by irradiation in these cases are less if the Wassermann reaction is positive

(8) **Interstitial irradiation should not be used unless the needles can be accurately placed** and uniform irradiation achieved. This provision excludes from cases suitable for interstitial irradiation many lesions which are inaccessible and some which affect parts of the mouth in which the shape is complicated. Irradiation from distant sources may be used for these lesions but it is difficult to perform this successfully without subjecting the normal tissues to a considerable intensity of irradiation and thereby exposing the patient to the risk of subsequent necrosis Thus some inaccessible lesions are best treated by operation.

(9) **Very old patients** sometimes tolerate the general discomfort and disturbance of irradiation badly and are better treated by operation which interrupts their normal routine less and allows a quicker return to near normal.

The choice between surgery and irradiation is unfortunately still affected by the fact that many surgeons are unaware of the possibilities and limitations of irradiation while many radiotherapists do not understand the factors which make for success or failure in surgery Until knowledge of these subjects is evenly distributed there will remain a large number of cases in which the treatment is dictated by the department which the patient happens to reach rather than by the necessities of the case Fortunately many growths which are curable respond almost equally well to either treatment

Technique of Interstitial Irradiation

Irradiation is destructive to all tissues and its use in the treatment of malignant disease depends on the attainment of conditions in which the injury inflicted on the normal tissues is capable of repair while that inflicted on the growth is not. These conditions are not so easy to attain nor are the advantages of the method so overwhelming as to render operation obsolete and the surgeon who has had no special experience in the use of radium and who finds himself compelled to treat carcinoma of the mouth either by operation or by interstitial irradiation is advised to use operative methods rather than to attempt the use of radium if he is hampered by insufficient knowledge and experience

Irradiation used in the treatment of carcinoma of the mouth may be applied from a near or a distant source external to the growth or directly by inserting needles into the affected tissues The technique of the first two methods is described elsewhere as surface and tele-irradiation

Interstitial irradiation is more within the province of the su It is applicable to most malignant lesions in the mouth whi suitable for irradiation though it is probably inferior to irradiation in the treatment of glandular metastases. It m emphasized that interstitial irradiation is a method which is c of doing a great deal of harm unless the principles of its use ar understood

Whether a surgeon is justified in using interstitial irradiatio has not the advantage of the co-operation of a physicist is a disp point There is no doubt that many excellent results have obtained in the past by interstitial irradiation calculated on em lines and it is equally true that even with the help of a physic not always possible to avoid the dangers and disadvantages of m dosage. At our present state of development it is fair to sa every surgeon who proposes to use interstitial irradiation work at some time with the co-operation of a physicist bu *having done so he will have acquired enough experience to use* stitial irradiation with reasonable success and safety without t of the physicist For this reason an account of rough meth estimation of dosage for interstitial irradiation is given below

Radium needles of many sorts are available but by no me of them are suitable for the treatment of carcinoma of the r The chief concern of the surgeon is to obtain needles of such l as will enable him to irradiate the tumour uniformly and which c radium in quantities which make it possible to deliver the desire *by leaving them in position for from 5 to 8 days* The type of which best conforms to these requirements is one which contai more than 0 75 mg of radium to each centimetre of its active l Needles of this type are spoken of as having a linear intensity c and provided that they are properly placed they can be l position for from five to seven days without fear of c necrosis

The standard radium containers recommended by the Na Radium Commission in March 1948 include types suitable f forms of interstitial irradiation but only a proportion of the suitable for use in the mouth Needles are classified accord linear intensity The lowest linear intensity is 0 33 and in thi the most useful needles are those containing 0 5 mg and 1 5 mg a total length of 2 5 cm and 5 8 cm respectively Needles a linear intensity of 0·66 are available with a content of 1 2 or with a total length of 2 5 4 2 and 5 8 cm respectively which are described as non uniformly loaded are also ava These are useful for interstitial irradiation planned with a ph when technical considerations make it necessary to have a sou radium originating from part of the length of the needle only

These non uniformly loaded tubes are more heavily screened the total screenage being 1 mm instead of 0 6 and they are consequently thicker

Technique based on the use of needles of this type is not universally employed Radiumhemmet for instance employs needles containing 10 mg of radium per centimetre of length and leaves them in position for 3 to 4 hours but where the technique of irradiation of special growths is described in the ensuing section it is assumed that needles of 0 75 linear intensity or less are in use.

Radon seeds are used when very small containers are required and when it is proposed to leave the source of irradiation permanently embedded in the tissues Radon seeds contain radium emanation in quantities varying between 0 5 and 2·0 millicuries in a growth of average dimensions in the mouth seeds with a content of 1 5 millicuries are suitable. As radium emanation exhausts itself rapidly and is reduced to half its strength in less than four days the dosage is heavier in the early part of the treatment when radon is used instead of radium. It is doubtful whether any mathematical standards can be laid down giving an accurate comparison of the biological effects of millicuries of radon and milligrammes of radium but 1 millicurie of radon left permanently *in situ* will deliver the same dose as 1 mg of radium left *in situ* for five and a half days A millicurie of radon removed at the end of four days will have given a dose equivalent to that given by 0 5 mg of radium in five and a half days Radon seeds may be regarded as inert after 21 days

Certain special instruments are necessary for the insertion of radium needles and radon seeds in the mouth Needles may be inserted through the skin after puncturing it with a tenotome and retained in place by means of a tiny piece of gauze soaked in mastic solution. Alternatively they may be inserted through the mucous membrane where they should be retained in place by a stitch inserted in the manner shown in Fig 750 If this stitch is tied sufficiently tightly it will cut out before removal of the needle is due

Estimation of the correct dose.—It is now customary to speak of dosage in terms of Roentgens denoted by r The Roentgen is a measure of ionization per cubic centimetre and is therefore a measure of concentration rather than of total dosage. It is important to remember that when a dose (of say 5 000 r) is given to a large tumour the total amount of irradiation entering the patient s body is greater than when a dose of the same denomination is given to a small tumour in exact proportion to the mass of tissue irradiated.

Dosage arrived at empirically in the early days of interstitial irradiation was calculated in milligramme hours i.e the number of milligrams of radium inserted multiplied by the number of hours over which they were left *in situ* The writer s own practice was to allow 0 75 mg of radium to each cubic centimetre of tissue to be treated leaving the radium *in situ* for seven days decreasing the intensity when it was necessary to irradiate very large masses of tissue and increasing



PLATE VIII.—Irradiation of the cheek with a sandwich applicator
(See Fig 751 and page 1830)

irradiated and drilled in such a way that needles inserted through the drill holes pass into a position which gives the desired pattern of irradiation By this method it is possible to insert needles with great accuracy Fig 749 shows an apparatus which was used for a total irradiation of the whole substance of the tongue the needles being inserted partly through the mouth and partly through the skin of the submaxillary region The perspex apparatus is made with a hinge so that the upper plate fits over the tongue in the mouth and the lower plate over the skin of the submaxillary region the substance of the tongue being embraced between the plates In Fig 749 dummy needles have been inserted through the holes in the perspex. Plate VII

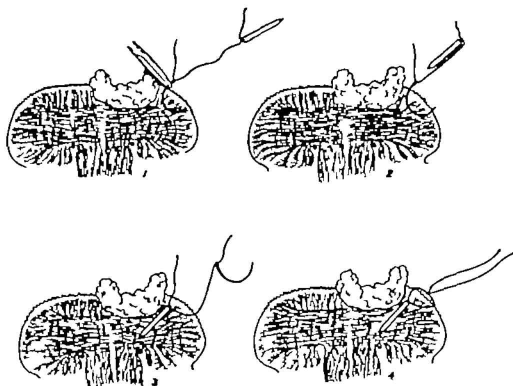


Fig 750 —Method of insertion and fixation of radium needles in the tongue

shows the radiograph of the needles in position in the tissues of the patient for whom this apparatus was constructed. For smaller lesions of less complicated shape perspex jigs can be readily constructed and are a great aid in securing distribution of needles

Whatever manner of implantation is adopted the insertion should be done at leisure with the patient under a full general anæsthetic and with full theatre facilities available The needles should have been threaded with strong silk previous to the operation As far as possible the insertion should be done with the tissues lying in their normal position as the distortion caused for instance by pulling the tongue fully out of the mouth before inserting the needle makes it certain that needles thus inserted would not be in the desired position when the tongue was allowed to fall back Needles inserted through mucous

membrane should be anchored by stitching by the method shown in Fig 750 and it is important that the threaded ends of the needles should not protrude through the mucosa during the course of treatment as if they do so they will produce burns in the mucosa. When the insertion is completed the threads of the needles should be bunched together and brought out through the corner of the mouth through a rubber tube of appropriate size as a single rubber tube is much less trying to the patient than a number of isolated threads.

After-care of patients undergoing interstitial irradiation.—Interstitial irradiation in the mouth may lead to serious pulmonary complications and the mouth must be kept as clean as possible. Swabbing is adequate for parts of the mouth other than those in which needles are implanted here washing with a Higginson s syringe or spraying with a dental hygienator is preferable. The patient is always more or less uncomfortable during the irradiation and requires a good deal of general nursing care. Feeding is particularly difficult during the later part of the irradiation when the mucosa becomes swollen and tender Salivation bothers some patients very much and if possible a suction apparatus should be at hand to deal with this complication.

Removal of needles.—Needles which come loose during the course of treatment should be removed at once. At the conclusion of treatment the needles can often be removed without a general anæsthetic as they lie loosely in the surrounding tissues Sometimes the threaded end of a needle catches beneath a fascial plane when this happens the needle must be urged out very gently without breaking the thread as once it is broken the needle may be very difficult to find. It is often better to use the thread as a guide along which a forceps may be passed to seize the needle rather than to pull on the thread itself

Much useful information on the technique of implantation and the after-care of patients will be found in two articles by J R. Nuttall.*

Irradiation by sandwich applicators.—Fig 751 and Plate VIII show a perspex apparatus used for irradiating a carcinoma of the cheek by the sandwich method The apparatus (Fig 751) consists of two disks of perspex drilled to take radium needles and in the figure they are held apart by pillars which occupy the space in which the thickness of the cheek and the tumour lie The disks were held in position by stitches running through the whole thickness of the cheek in the position in which the pillars stand Plate VIII is a radiogram of the patient with the apparatus in position. Irradiation by this technique should not be attempted without the aid of a physicist.

In all forms of interstitial and surface irradiation the surgeon must remember that the two most serious errors which he can commit are overdosage and irregular dosage. There is a tendency to use larger doses in advanced growths It cannot be too strongly emphasized

* *Brit Journ. Radiol* (1943), xvi, No. 182, 43 *ibid.*, No. 183, 72.

that an increase of the dose beyond the ordinary limits in these circumstances does not produce an increased effect on the cells of the growth and defeats the object with which it is used by damaging the cells of the normal tissues Thus as Berven says * Overdosage gives rise to necrosis with rapid growth of the tumour Irregular dosage is an even more serious error for it leads to the persistence of areas of inadequately treated growth in the midst of necrosed normal tissues A patient who has suffered as a result of this error is left in a pitiable condition with growth uncured in the midst of tissues which have been

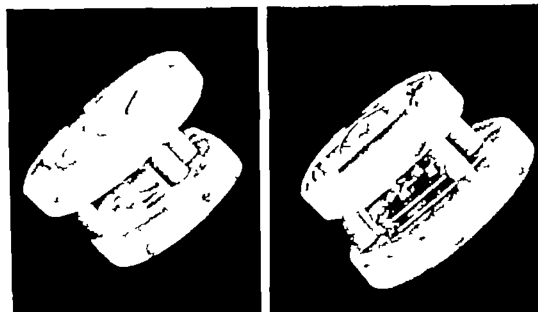


Fig. 751.—Perspex apparatus used in irradiating the cheek.

so badly damaged that they are incapable of resisting any further trauma. Such patients are still occasionally seen and their condition is far worse than that of untreated cases

The total dose.—It does not generally happen in the mouth or tongue that the total dose of irradiation is sufficient to give rise to severe general symptoms Most patients even if their physical condition is poor will stand a dose of 3 000 to 5 000 mg hours spread over 7 or 8 days without suffering anything more than a mild general malaise though there is a certain amount of individual variation Nevertheless a surgeon who is working without a physicist should always estimate the total dose in milligramme-hours which would be given by the plan he has made and if he finds it excessive the plan must be altered. When it is necessary for this reason to reduce the dose applied to the growth it is better to thin out the needles in the centre of the growth while adhering to the original plan at the periphery

Diathermy —By diathermy a growth may either be coagulated *en masse* or separated from its surroundings by using the diathermy point

* *Acta Radiol*, 1937 xviii, 18.

as a knife The latter method has certain advantages over ordinary excision First there is much less bleeding at the time of operation, and it is consequently easier for the surgeon to appreciate the exact relation between the borders of the growth and the limits of his excision Secondly there is some evidence that heat exercises a selective influence on the cells of malignant neoplasms and that these cells are destroyed by endothermy in an area wider than that in which the normal tissues are damaged Thirdly it is supposed that the sealing of the lymphatics which takes place when tissues are divided by diathermy is a protection against the development of metastases. In the post-operative period patients who have been treated by diathermy show remarkably little general disturbance. Pain is usually slight, and after the sloughs have separated the resultant scar is soft and pliable

There are however certain disadvantages. It is almost impossible to avoid sparking in the tissues and therefore inflammable anæsthetics such as ether cannot be used A certain amount of sloughing in the region of the wound is inevitable and primary union after diathermy excision is therefore very difficult to obtain Secondary hæmorrhage may occur during the separation of the sloughs. Diathermy is useful when it is desired to treat a large fungating growth of the exfoliative type by interstitial irradiation. In such cases the exfoliated part of the growth is removed with the diathermy knife leaving only the base and the infiltrating portion of the lesion to be treated by irradiation. By this means it is possible to reduce the total amount of irradiation and to obtain greater accuracy in making radium implants.

Diathermy coagulation is not much used in this country but it is part of the regular technique at Radiumhemmet where it is used as a primary treatment and also to destroy the site of a previously irradiated growth It is often followed by necrosis of bone This is not a serious matter when the upper jaw is affected, but in the lower jaw it is an extremely serious and dangerous complication and it is seldom justifiable to use diathermy coagulation for lesions which lie in close relation to the lower jaw

Diathermy excision is probably less efficient than coagulation in securing destruction of malignant cells beyond the obvious limits of the treated area, but the resulting wound becomes clean much sooner and heals more rapidly

Pre-Operative Treatment in Carcinoma of the Mouth

Extensive operations and irradiations in the mouth throw a very considerable strain on the general health of the patient and the ability to resist infection and to restore damaged tissues to normal is a factor of great importance in recovery In all cases time must be found for a certain amount of preliminary treatment both general and local before the major interference is undertaken and it is surprising to see how often this appears to exert a beneficial effect on the growth itself

General treatment consists mainly in good nursing and good food for many patients are quite exhausted by pain and semi-starvation when they apply for treatment Most of them improve greatly under proper nursing care A very important part of the routine is mechanical cleansing of the growth Mouth washes of sodium bicar bonate and hydrogen peroxide are useful and spraying with a dental hygienator is very helpful if the stream is properly adjusted It is impossible to build up a patient who cannot ingest an adequate amount of nourishment and patients should be instructed in the use of a rubber tube attached to a feeding cup a device which enables them to take fluids with the minimum of discomfort. If swallowing is very painful and difficult there may be sufficient justification for temporary gastrostomy This operation may be easily done under local anæsthesia and as soon as the artificial opening is functioning satisfactorily the patient begins to gain ground Patients who have had gastrostomy performed are not only more easily fed but also suffer less from pain and excessive salivation

Preliminary tracheotomy must also be considered The indications for it are less than they were in the days before antibiotics as pul monary complications are now much less formidable and the risk of a tracheotomy done at the time of the main operation is not as great as it was in the past Even so a patient who has a foul ulcer runs a considerable risk of developing pulmonary complications when this ulcer is interfered with whether by operation or irradiation Also the immediate effect of irradiation may be to increase the size of the mass by producing œdema round it and, if the growth is near the upper opening of the larynx this may induce dyspnœa where it did not exist before. A further consideration must be taken into account in operations which interfere with the normal muscle attachments in the floor of the mouth and the tongue. Patients who have undergone such operations are liable to attacks of mechanical respiratory obstruction however carefully they are nursed and there is reason to believe that if the anoxæmia which occurs in these attacks is sufficiently severe and sufficiently prolonged it may lead to irreversible cerebral changes which are later responsible for the death of the patient Taking all these factors into consideration the operator must decide whether or not a tracheotomy is likely to be required If it is thought that tracheotomy will be required and the patient is in poor con dition already it is better to do the tracheotomy some 10 days before the main operation Most patients develop some degree of bronchitis as a result of the tracheotomy and preliminary tracheotomy alone carries a mortality but the case which is lost after preliminary tracheotomy is certainly not one which would have survived the major operation together with tracheotomy

In cases in which there are no gross signs of pulmonary disease and tracheotomy is required only to avert the danger of post-operative respiratory embarrassment it may safely be done at the time of the main operation.

Preliminary tracheotomy in a patient who is not dyspnoeic is easily performed under local anæsthesia. Trotter laid particular stress on the necessity of removing a disk from the wall of the trachea instead of making a vertical incision as this step avoids sloughing and makes the changing of the tube easier He used only St Clair Thomson's modification of Durham's tube.

If it is decided that gastrostomy and tracheotomy are unnecessary consideration must be given to the method by which it is proposed to feed the patient after operation Active propulsion of fluids from the mouth to the pharynx is generally impossible for a time after extensive operations or irradiations in the mouth A Ryle's tube passed through the nose before operation and left *in situ* is a convenient means of administering adequate fluid nourishment but some patients prefer an ordinary feeding cup with a rubber tube attached to the spout by which fluids can be delivered straight into the pharynx.

Patients who have a small chest expansion are particularly liable to pulmonary complications The chest expansion can be considerably increased by suitable exercises and patients whose chests are very rigid should undergo a preliminary course of chest exercises in the pre-operative period and should be urged and encouraged to carry out similar manœuvres during the immediate post-operative period.

Dental treatment.—No major operation in the mouth should be attempted when gross dental infection is present Extraction of septic teeth diminishes the risk of post-operative sepsis and respiratory complications and also contributes to the well being of the patient by reducing salivation and discomfort Occasionally the direct effect on the primary lesion is very marked and a growth which has appeared inoperable by reason of its size and fixity may be found to be operable after sepsis has been reduced by removal of infected teeth.

The practice of removing all teeth whether septic or not is unjustifiably drastic Dental extraction is a major operation which is not free from risk in elderly patients particularly when the teeth are firmly fixed and it is better to insist on extraction only of those teeth which are grossly infected and to advise conservative treatment for the rest The gums must be allowed to heal completely before any further operative treatment is undertaken and to ensure healing in the shortest possible time great care must be taken not to inflict unnecessary damage on the alveolus by rough manipulation during extraction.

Radium treatment is less effective and more likely to cause necrosis of the jaw if infected teeth are present. Metal bridges and fillings are an important cause of secondary irradiation at the time of treatment and the susceptibility of an irradiated jaw to trauma is so greatly enhanced for many years after radium treatment that even a simple tooth extraction may produce widespread necrosis. For all these reasons teeth which are heavily stopped, and those which are likely to give trouble in the near future should be removed before treatment

by irradiation is begun. Other teeth may be scaled and metal work removed but sound teeth should not be disturbed.

Preliminary treatment with antibiotics.—There is no doubt that the disastrous complication of sepsis invading the tissue planes of the neck after a major operation on the mouth has become much less common as a result of antibiotics and sepsis of the degree which leads to secondary hæmorrhage is now very rare. All patients on whom it is proposed to carry out an operation on the mouth or a major interstitial irradiation should receive a routine preparation with penicillin and streptomycin for 48 hours before operation.

Biopsy.—Biopsy should be done when there is any doubt of the diagnosis In other cases even when diagnosis is certain microscopic structure gives valuable indications of the most appropriate form of treatment. The tissue removed must include a part of the growing edge of the tumour and must be of a size and shape which enables the pathologist to be certain of cutting the section at right angles to the surface. Preliminary teleradiation is sometimes used to reduce the risks of metastasis when the growth is cut into for biopsy

Preliminary control of hæmorrhage.—Trotter stated that he had never done an operation for preliminary control of hæmorrhage in an operation on the mouth or jaws and had never regretted the omission Most surgeons prefer to ligature the external carotid artery before excising the upper jaw as the bleeding which otherwise occurs makes it difficult to perform the steps of the operation accurately Collateral circulation is very rapidly established in the mouth and neck and unless the artery is ligatured immediately before the principal operation there is little effect on the amount of bleeding In major operations on the side of the tongue and pharynx the artery is generally ligatured as part of the operation. The formal operation for ligature of the external carotid is described at p. 569 Vol. I.

ANÆSTHESIA IN OPERATIONS FOR MALIGNANT DISEASE

Operations on the anterior part of the tongue and the floor of the mouth can be satisfactorily performed under a combination of local and regional anæsthesia after blocking the lingual and inferior alveolar nerves by Braun s method. Simple local anæsthesia is adequate for the lip and cheek.

Local anæsthetics reduce hæmorrhage from small vessels and make operative technique easier It is claimed that they also reduce the incidence of chest complications This is probably true but it must be remembered that inhalation of anæsthetic vapours is certainly not the only cause of chest complications and probably not the main one so this point should not weigh too heavily in the choice The majority of patients in this country are not very receptive to the idea of local analgesia, and it often has to be supplemented with some form of

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the technical steps are simplified if the blood pressure is artificially lowered Artificial lowering of blood pressure is accompanied by some risk the extent of the risk varying with the skill of the anæsthetist and the method used and the condition of the patient It is as yet too early to say whether the advantages compensate for the added risk. The writer generally works without lowered pressure but uses it for operations which are exceptionally extensive In these cases the pressure is generally lowered by the administration of an extradural spinal anæsthetic *

Methods of Exposure

These methods are grouped together as any one of them may be used for the exposure of growths in several situations They may be used as the preliminary stage of an operation or occasionally to expose a growth for interstitial irradiation

1 **Horizontal splitting of the cheek.**—This is a very useful method of exposing growths which lie far back on the side of the tongue or on the posterior part of either alveolus and has the advantage that it does not open up the tissue planes of the neck to infection from the mouth The whole thickness of the cheek is divided from the angle of the mouth to the anterior edge of the masseter the incision being kept below the line of the parotid duct (Fig 752.) Bleeding is fairly free but it is easily controlled by ordinary methods and diathermy should not be used as it jeopardizes the chances of primary union. As soon as the incision is made and the larger vessels ligatured a fine continuous stitch is used to bring mucous membrane and skin in close contact over the raw surface throughout the wound This temporary stitching-over prevents contamination and checks oozing At the end of the oral part of the operation the continuous stitch is removed and the cheek united

The mucous membrane is sutured carefully and accurately with a fine catgut stitch. In closing the skin it is best to make use of stitches which are passed in the ordinary way and then again catch up the extreme edges of the skin wound in such a way that when tied they evert the edges a little. Wounds which are sutured in this way produce ultimately an almost invisible scar those which are sutured in the ordinary way are liable to show more because the scar becomes depressed. Nearly all wounds in the skin of the cheek heal well and in infected cases it is better to make no attempt to close the skin edges accurately but simply to draw the whole thickness of the cheek together with one or two loose stitches Wounds allowed to heal in this way generally give excellent scars

By extending this incision further back across the edge of the masseter and raising the muscle and the parotid gland the greater part of the ascending ramus of the jaw can be exposed

If the incision is kept in the line of the gap between the upper and lower alveoli and is not extended more than a centimetre or so behind

* Gardham, *Ann. Roy Coll. Surg.*, 1948 6 291

basal or inhalation narcosis so that as regards toxicity there is often little to choose between this and an ordinary general anæsthetic. Local anæsthetics are not very suitable for cases requiring interstitial irradiation as the œdema which results from the injection obscures the outlines of the growth and makes it difficult to be sure of inserting the needles accurately

Basal anæsthetics are pleasant for the patient but have the disad vantage that they depress respiratory activity in the post-operative period Probably the most satisfactory combination is preliminary intravenous injection of 3 to 4 c.c. of sodium evipan followed by gas oxygen and ether administered either by the nasal intratracheal route or through a tracheotomy so that the surgeon can plug off the pharynx completely from the mouth

The only serious disadvantage of the nitrous-oxide-ether method is the impossibility of using it with diathermy Sparking in diathermy operations can never be entirely eliminated and there is a very serious risk of explosion if it is allowed to occur in the neighbourhood of ether vapour It is generally considered to be safe to induce anæsthesia with ether in these cases and to change over to a non-inflammable anæsthetic a few minutes before the diathermy apparatus is brought into use This method is very commonly employed and no accidents have been recorded but it is doubtful whether it is absolutely safe.

Trotter stated that if a tracheotomy is to be done chloroform is the only anæsthetic. Given through a tracheal opening it has proved, in a very large experience to be entirely safe The only danger is during the period of induction before opening the trachea. Such danger can be minimized by beginning the induction with the patient on the table and the surgeon ready to operate it can be avoided entirely by a preliminary tracheotomy under local anæsthesia. In patients with an ulcerating growth and salivation the least sniff of ether should be forbidden Given through a tracheotomy opening with a plugged pharynx chloroform is rarely followed by vomiting'

Whatever method is used for anæsthesia it is very important that the patient should enjoy free and unobstructed respiration A patient who has through the course of a prolonged operation struggled for breath never emerges from the operation in such good condition as one who has had a free airway and congestion of the vessels of the neck add formidable difficulties to the technical steps of the operation and may embarrass the operator sufficiently to make it very difficult for him to adhere to his prepared plan It is much better to delay the start of an operation until the anæsthetic difficulties have been sur mounted than to embark on one in the very unfavourable conditions induced by cyanosis and congestion of the neck vessels.

The extent to which it is justifiable to use the modern methods of artificial reduction in blood pressure in operations on the mouth and pharynx is still in doubt There are few operations which cannot be performed with reasonable ease with a simple anæsthetic provided that the airway is kept clear and the anæsthetic skilfully given, but

before inwards and backwards in order to leave two broad surfaces of bone for apposition Division should be made with a saw in order to avoid splintering and subsequent sequestration The two halves of the jaw are then pulled apart by means of sharp hooks inserted into the cavity of the bone The further steps of the operation depend on the lesion which it is desired to remove

This method gives a good exposure of growths situated in or near the midline beneath the frenum of the tongue and makes it possible to expose these and remove them adequately with a sufficient margin of surrounding tissue It can also be made to give a good exposure of the central part of the tongue by dividing the mucosa on either side of the floor of the mouth with scissors and pulling the tongue forward after dividing the mylohyoid muscles in the midline and separating the geniohyoids from their insertion into the jaw

It is possible by this operation to remove nearly the whole of the tongue. The lingual arteries are encountered in the floor of the mouth as they emerge from under cover of the hyoglossus muscles and can be secured without difficulty The tongue is held back by the anterior pillar of the fauces and the styloglossus muscle and both must be divided before the tongue can be brought right forward

If it is necessary to remove any considerable portion of the tissues of the floor of the mouth the sublingual glands must necessarily be sacrificed and the submaxillary duct on one or both sides will be divided No special steps need be taken to re-implant the duct

This operation can be adapted to allow removal of growths which extend far back in the floor of the mouth but is not generally very suitable as most of these growths require removal of the submaxillary gland which is much better approached through a lateral incision

In the subsequent repair an attempt must be made to provide an adequate covering of mucous membrane in the floor of the mouth As a rule the two halves of the jaw are united by silver wire but thick catgut is sometimes used The skin edges are drawn loosely together leaving ample space for drainage It is often better to leave the lower end of the wound open packing it loosely with petroleum jelly gauze

If this operation is carefully carried out in suitable cases it gives an excellent exposure without involving much risk of infection in the tissue planes of the neck The wire often has to be removed subsequently and small sequestra may form at the site of division of the jaw but failure of union and massive sequestration are both very rare unless the jaw has been previously irradiated so that at the worst the patient has only a small sinus until the wire or the sequestra are removed. Modifications of the operation may be devised to suit extensive growths which have infiltrated the bone. If the region has previously received a full dose of irradiation the post-operative course may be very stormy The impairment of nutrition which follows such treatment entirely changes the reaction of the tissues to trauma and if the operation described above is performed after irradiation it may be followed by an external salivary fistula and

the edge of the parotid gland any facial paralysis is very unlikely and by using the incision in this way extensive growths which affect the posterior part of the alveolus can be adequately exposed and removed without undue difficulty

2. **Division of the lower jaw in the middle line. Syme's method.** – This gives an excellent exposure of localized growths in the floor of the mouth The operation begins with the extraction of the two central incisor teeth An incision is then made from the middle of the lower lip to the hyoid bone keeping accurately to the middle line. Some operators prefer to extend the lower limit of the incision laterally to both sides at the level of the hyoid converting it to a T or Y shaped incision This gives a better exposure of the sides of the tongue

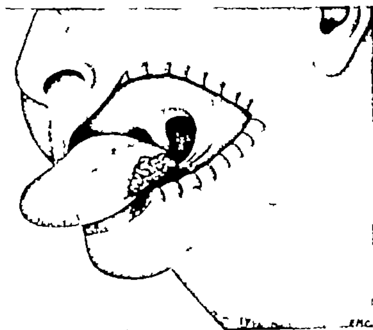


Fig 752.—Side of tongue and fauces exposed by horizontal division of cheek. The skin and mucous membrane along the edges of the incision have been temporarily united by a continuous stitch to prevent infection.

The whole thickness of the lip and the soft tissues overlying the chin are divided but from the point of the chin to the hyoid bone only the skin the subcutaneous tissue and the platysma are included in the primary incision so that the fatty tissue of the submental triangle which may contain lymphatics infiltrated with growth is left undisturbed This fatty tissue is then dissected up clearing the triangle enclosed between the anterior bellies of the digastric muscles and the hyoid bone and exposing the mylohyoid muscles A point is selected for division of the jaw usually through the socket of one of the incisor teeth just to one side of the midline Holes are drilled on either side of the proposed line of division to facilitate subsequent union of the jaw The bone is then divided by an oblique cut running from

because it paralyses the lower lip A possible method is to make a midline incision through the lower lip and to turn it sharply backwards along the lower border of the jaw In this way the lip with most of its nerve supply intact is turned back off the jaw until the place for dividing the bone is reached The bone is divided obliquely so as to facilitate its subsequent reunion at the junction between the ascending and the horizontal ramus and the mucous membrane is incised just in front of the palatoglossal arch This operation gives fair exposure of the side of the tongue and the oropharynx but is inferior in this respect to the method next to be described It also obscures the field if a subsequent dissection is required in the submaxillary triangle In general it may be regarded as a compromise between the method of anterior median division and that of lateral division with clearance of the submaxillary triangle but it is neither as safe as the first nor as radical as the second and its use is seldom indicated. It may leave the patient with a lower lip which is very unsightly as a result of œdema and partial paralysis

The best lateral approach to the tongue is achieved by an operation which involves preliminary clearance of the submaxillary triangle on one side

The operation is performed as follows —

An incision is made through the skin superficial fascia and platysma from a point just behind the mastoid process downwards along the middle of the sterno-mastoid as far as the level of the hyoid and turning upwards and forwards from there to the point of the jaw The large U-shaped flap marked out is turned upwards exposing the contents of the submaxillary triangle and the outer surface of the horizontal ramus of the jaw The lower end of the parotid gland can be included in the flap and turned upwards with it after dividing the external jugular vein as it emerges from the lower border of the gland and the large communication which runs from it to the common facial vein The facial vein itself and its accompanying artery are divided at the level of the alveolus just in front of the masseter The anterior border of the sterno-mastoid is now defined and retracted backwards and the external carotid artery is exposed at its origin by dividing the common facial vein and drawing the posterior belly of the digastric forwards The external carotid artery is ligatured in continuity but not divided for fear of a secondary hæmorrhage from its stump

The margins of the submaxillary triangle are now defined and the contents of the triangle are removed after dividing the facial artery near its origin from the external carotid. The base of the wound now consists of the outer surface of the lower jaw covered posteriorly by the masseter muscle Below this in the anterior part of the wound is the mylohyoid Farther back the hyoglossus is exposed and still farther back lie the superior and middle constrictors of the pharynx with the styloglossus disappearing between them to the side of the tongue

At this stage if the growth lies far back on the lateral border of the tongue or in this portion of the floor of the mouth it can be palpated

massive necrosis of the jaw In some cases it is necessary to face t risks in order to take the chance of curing a patient who has a pe sistent growth after full irradiation but generally other methods approach allowing removal of more bone are better

Kocher after abandoning his lateral submandibular operation us a midline approach for nearly all extensive growths of the tong He did not separate the soft parts and the periosteum from the ja



Fig 753 —Exposure of sublingual growth by division of the jaw just to the right of the midline.

A, mylohyoid muscle B, digastric muscle; C, submaxillary gland D mucosa of floor of mouth. The lingual nerve has been removed. The insertions of the genioglossus and geniohyoids are left intact and the complete tongue is drawn over to the left.

and the bone was divided a little to one side of the mid line so that t insertions of the genioglossi and geniohyoids remained intact on t sound side The tissues of the floor of the mouth were then divid in a line determined by the position of the growth and the tong was drawn over to the sound side as the two halves of the jaw we separated. (Fig 758) This method gives a very fair exposure of t side of the tongue and according to Kocher the incidence of pu monary complications is low because the mechanism of swallowi is preserved Apart from this it has no real advantage over later division of the jaw which gives a better exposure.

8 **Lateral division of the jaw** —Langenbeck s original plan whi employs an L-shaped incision splitting the cheek and turning dow wards in front of the angle of the mandible should never be us

forwards and will reach nearly to the position of the symphysis. This increases the stability of the jaw but in fact the disability which results from removal of the whole of the ascending ramus and a large portion of the horizontal ramus is surprisingly slight. Patients from whom a portion of the lower jaw has been removed for a malignant growth should not be encouraged to undergo any form of plastic repair for at least two years from the time of the original operation because of the risk of recurrence. Many of them learn to adapt themselves



Fig. 754.—These photographs show a patient 4½ years after removal of the greater part of the ramus and right side of the body of the jaw for carcinoma of the tongue and fauces. No attempt has been made to reconstruct the jaw. The patient wears a denture and states that he does not restrict his diet in any way.

so well in this time to the presence of a fibrous union and suffer so little disability that plastic repair is contra-indicated even after the danger period for recurrence has passed (Fig. 754).

Lateral division of the lower jaw just in front of the angle after clearance of the submaxillary triangle by the method just described gives a complete exposure of the whole tongue together with the epiglottic region and the pillars of the fauces and it is the best available method for removal of extensive growths. Modern conditions have greatly reduced the mortality of operations of this type and immediate fatalities are uncommon.

Closure is relatively easy if a considerable portion of the lower jaw has been removed and the size of the floor of the mouth has consequently been reduced but it is difficult when the jaw has only been divided and reunited. Repair is best effected by inserting interrupted sutures of catgut in such a way that the soft tissues immediately deep to the mucosa are brought into apposition and it is often better not to include the mucosa itself within the grip of the suture. When it has

by inserting a finger beneath the lower border of the mandible and some idea obtained of its extent. The subsequent steps of the operation depend on the size and shape of the lower jaw and on the situation of the growth and its attachments. If the patient is a woman with a lightly built jaw and the growth lies sufficiently far from the jaw to leave a reasonable margin of mucosa between it and the alveolus, it may be possible to secure a sufficient exposure by dividing the mucosa in the alveolo-lingual sulcus in the molar region and prolonging this incision forward through the mucosa of the floor of the mouth and the mylohyoid muscle until the side and base of the tongue can be drawn out into the wound. In this way the lateral side of the posterior part of the tongue can be exposed as far down as the epiglottis.

In patients whose lower jaws are more heavily developed and when a higher exposure of the side of the base of the tongue is required this can sometimes be achieved in the following manner. An incision is made through the masseter muscle exposing the posterior margin of the ascending ramus and the lower margin of the horizontal ramus for about 1½ in from the angle and the muscle is raised from the underlying bone with a periosteal elevator. The elevation is continued until the point of the elevator can be inserted into the mandibular notch between the condyle and the coronoid and with its aid the masseter and the overlying parotid are held upwards and forwards. A triangular portion of the angle of the jaw is then removed. The internal pterygoid muscle is freed from the inner aspect of the jaw and displaced upwards and the mucosa is opened between the tongue and the jaw in the molar region. In a favourable case the whole of the base of the tongue can be exposed by this method and the tongue can be delivered through the neck incision. The inferior alveolar nerve and artery are generally divided when the triangular portion of bone is removed.

In heavily built men it may be impossible to obtain an adequate exposure without dividing the whole width of the jaw. It is also necessary to do this if it is desired to obtain a view of the pillars of the fauces and the tonsillar fossa or if the growth is close enough to the bone to make it necessary to remove a part of it. At the present day many of the cases which come for this operation have previously undergone irradiation and in this case it is generally safer to remove a considerable proportion of the bone in the irradiated area rather than to traumatize it and run the risk of a subsequent necrosis. If it is necessary only to divide the bone the line of division should run obliquely downwards and forwards from the socket of the posterior molar tooth and holes should be drilled to facilitate the insertion of suture material for subsequent retention of the fragments before the bone is divided. If it is necessary to remove the greater part of the ascending ramus together with part of the horizontal ramus it is possible to retain a strip of bone formed of the condyle the neck and a narrow piece of the posterior part of the ascending ramus removing the anterior part of the ascending ramus and as much as is necessary of the horizontal ramus. The strip of bone left subsequently angulates

Once the mucosa is divided the greater part of the separation can be done by blunt dissection the two halves of the jaw and the corresponding soft tissues being gradually drawn away from one another In Trotter s own words — The advantages of the median operation are that when exactly carried out it is almost entirely bloodless that it follows a natural line of cleavage that infective complications are almost non-existent and that it gives the best access in the direction in which it is most needed

The application of the method is a little more difficult in practice than the description implies as it is not always easy to find and follow

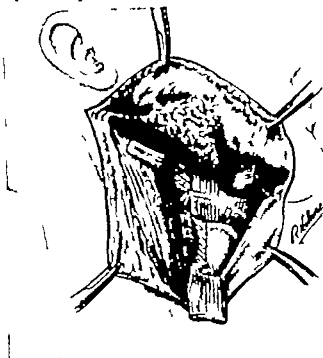


Fig. 756.—Transthyroid pharyngotomy

Stage I of lateral transthyroid pharyngotomy by Trotter's method without removal of the sterno-mastoid. The lateral lobe of the thyroid gland has been removed and the great vessels have been covered by stitching the anterior border of the sterno-mastoid to the prevertebral muscles. The digastric muscle has been divided and its posterior belly has been used to complete the protection of the great vessels above. The line shows the attachment of the inferior constrictor to the ala of the thyroid Growths may perforate the pharyngeal wall in this line.

the exact midline of the tongue but growths which involve the base of the tongue and do not spread far from the midline are better exposed by this method than any other and the functional result after closure is excellent. The steps of the operation concerned with the removal of the growth and the subsequent repair are described on p 1885

Lateral transthyroid pharyngotomy —This operation more than any other is associated with the name of Trotter He used it extensively for exposure of growths in the lateral part of the pharynx and post-cricoid region The approach serves for the exposure of a number of growths which differ considerably in their clinical characteristics and methods of extension including those of the lateral wall

been possible to appose the cut edges of the mucosa satisfactorily the skin wound should be closed completely the skin flap being held down to the underlying tissues by means of a few mattress sutures. When closure of the mucosa is unsatisfactory it is better to leave a corresponding portion of the skin wound unsutured as a limited fistula is better than a widespread infection Fistulæ commonly close spontaneously and even if they do not the operation for closure is not difficult As the lower lip is not divided there is little subsequent deformity and the œdema of the lip which mars the result of excisions which involve splitting the whole thickness of the lip is not seen.

Trotter who advocated the skin incision described above recommended this operation combined with a lateral exposure of the pharynx for extensive growths which originate in the tonsillar region and involve the lateral pharyngeal wall. A vertical cut is made from the anterior part of the incision to the front of the lower end of the sternomastoid. The incision thus becomes Z shaped and by turning back the flaps so marked out the thyroid ala and the body and great cornu of the hyoid are exposed and resected. A limited gland dissection is done, the anterior branches of the external carotid are ligatured and divided and the lingual hypoglossal and superior laryngeal nerves are deliberately severed The mandible is now divided between the horizontal and ascending rami and a complete lateral exposure of the pharynx is obtained

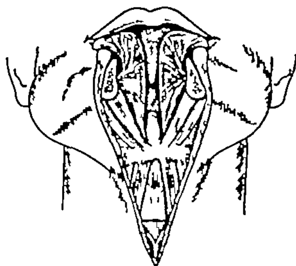


Fig 755.—Exposure of hypoglottic region by Trotter s midline approach.

4. **Median division of the tongue** —This method was advocated by Trotter for growths involving the base of the tongue. A preliminary tracheotomy was always done and the operation consisted in a division of the jaw the floor of the mouth and the tongue in the middle line The operation is described by Trotter in the following words — An exactly median incision is made over the lower lip the chin and the submental region to the top of the thyroid cartilage The cut is deepened first below until the mylohyoid muscle has been divided and then the interval between the geniohyoid muscles is found close to the hyoid bone. This interval is the best guide to the middle line and it is opened up as far as the jaw The incision is now carried through the lip down to the mandible which is sawn through exactly in the middle line The same line of cleavage is followed through the floor of the mouth to the tongue which is then split in the same way (Fig 755)

Once the mucosa is divided the greater part of the separation can be done by blunt dissection, the two halves of the jaw and the corresponding soft tissues being gradually drawn away from one another In Trotter s own words — The advantages of the median operation are that when exactly carried out it is almost entirely bloodless that it follows a natural line of cleavage that infective complications are almost non-existent and that it gives the best access in the direction in which it is most needed

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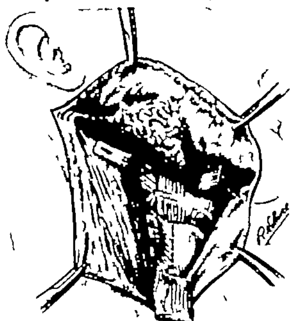


Fig 756 —Transthyroid pharyngotomy

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of the pharynx those situated round the upper opening of the larynx and those of the post-cricoid region.

Trotter said * The operation of lateral transthyroid pharyngotomy is the foundation on which all the different procedures from the simplest to the most elaborate must be built up It is primarily a method of access and depends on the anatomical fact that the laryngo-pharynx lies within the laryngeal skeleton If the great cornu of the hyoid bone and the ala of the thyroid cartilage are removed the wall of this part of the pharynx is disclosed unopened and through it the situation and extent of a growth can be determined by palpation with some precision

When Trotter practised this operation he did not have the advantages of modern anæsthesia, chemotherapy or antibiotics. As a result of this pulmonary complications were frequent and in many cases the operation was followed by severe septic complications which sometimes ended in fatal secondary hæmorrhage. In spite of this Trotter attained some very striking successes and really opened the door for the surgeons of the present generation It is not sufficiently realized that under modern conditions lateral pharyngotomy is not a dangerous operation and with ordinary care and proper use of modern facilities neither pulmonary complications nor sepsis gives rise to much trouble.

Skin Incision.—Trotter originally approached the pharynx through a vertical incision over the middle of the lateral aspect of the larynx and attempted complete closure of the pharynx at the primary operation. He later abandoned this and in a personal communication shortly before his death he wrote I am now convinced that in lateral pharyngotomy no attempt should be made to secure primary closure of the pharynx In every case the operation from the first should be designed deliberately to terminate with the making of a temporary fistula. The object of this is to secure the immediate and complete covering in of all raw surfaces This change of technique has greatly reduced the danger of serious sepsis and the gravity of the operation

In pursuance of the object of making a temporary fistula and completely covering all raw surfaces the skin incision must be designed to produce a flap the edge of which can be approximated to the edges of the defect in the pharynx. The details of the incision vary according to the side on which the growth is situated the level at which the fistula is expected and also with the presence or absence of hair on the skin of the neck Hair bearing skin should not be used in the portion of the flap designed to meet the defect in the pharynx as growth of hair in the skin which has been used to reconstruct a portion of the wall of the pharynx is a very troublesome late complication. If the skin is hairless a large rectangular flap with its base hinging on the posterior border of the sterno-mastoid is excellent and can be used to establish a skin lined fistula at any level. The anterior limit of the

* "The Surgery of Malignant Disease of the Pharynx," *Brit. Med. Journ.*, 1926, i, 269.

flap must not extend much beyond the midline of the neck if sloughing of the flap is to be avoided and in some cases such as growths of the lateral wall of the pharynx where a limited excision only is necessary the flap is better constructed to terminate anteriorly an inch or so before the midline

When the skin of the neck is hairy the design of the flap requires some ingenuity Trotter recommended an incision of a triradiate form with an oblique component running downwards and forwards from the mastoid to the region of the prominence of the thyroid cartilage and a vertical component descending from about the middle of this. The oblique component should outline the edge of the beard and then any skin lying below and behind this can be safely turned into the pharynx to establish the fistula.

When the growth to be removed is in the post-cricoid region it may be possible to separate it from the larynx leaving the cricoid and the structures of the larynx in position In such cases extensive skin flaps are required to replace the post laryngeal part of the œsophagus. A useful flap can be obtained from the infraclavicular region in the manner shown in Fig 757 the pharynx being first exposed by turning back a flap based just on the sound side of the middle line and extending as far as the middle of the sterno-mastoid on the affected side (A B C D) The flap E F G H has its base in the loose skin of the posterior triangle. It is fashioned after the growth has been excised and is swung upwards and towards the midline in front of the great vessels and sutured to the prevertebral fascia. The raw area in the infraclavicular region is covered with a Thiersch graft. Fig 769 (p 1890) shows a case in which it was necessary to remove the whole circumference of the post laryngeal œsophagus and reconstruction was carried out by this method.

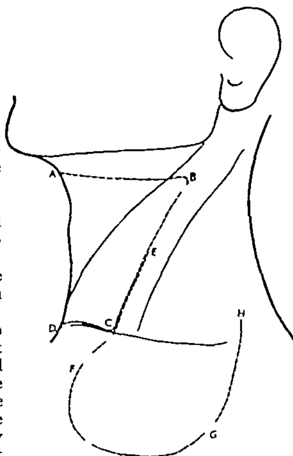


Fig. 757 —Transthyroid pharyngotomy Diagram to show skin-flap required for repair of post laryngeal œsophagus.

Gland dissection —If the lymph nodes beneath the sterno-mastoid are already involved the operation must commence with their removal

Trotter did not remove the sterno-mastoid as he preferred to keep it as a guard for the carotid vessels and was satisfied with a gland dissection as adequate as he could obtain without removing the muscle. With the diminution of the danger of septic complications it is possible to remove the sterno-mastoid and to do a radical dissection of the deep cervical glands as the first stage of the pharyngotomy It is not generally necessary to remove the contents of the submaxillary triangle. The decision as to whether gland dissection should be done as a preliminary to pharyngotomy depends on the condition of the nodes and the build and general condition of the patient It adds perhaps an hour to the time of the operation. Trotter concluded his partial gland dissection by covering the great vessels of the neck with the sterno-mastoid stitching the anterior border of the latter muscle to the prevertebral muscles behind the pharynx and closing the small gap which was left at the upper end with the posterior belly of the digastric after the digastric tendon had been divided

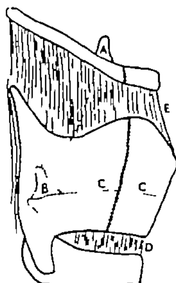


Fig. 758 —To illustrate the principle of the operation of lateral transthyroid pharyngotomy The outline of the laryngeal skeleton is shown. The finely dotted lines indicate the relative positions of the ary-epiglottic fold, the arytenoid cartilage and the vocal cord. The thickly dotted lines show where the great cornu and the thyroid ala are divided in the operation. When these parts have been removed the laryngo-pharynx is accessible.

A, Epiglottis. B, Arytenoid cartilage. C, Vocal cord. D Crico-thyroid membrane. E, Thyro-hyoid membrane.

In all cases the external carotid artery should be exposed and ligatured in continuity near its origin as this makes the subsequent steps of the operation less difficult. The artery should not be divided as there is some evidence that secondary hæmorrhage is more frequent after division than after ligature in continuity

Exposure of the pharynx.—If the growth is in the post-cricoid region the next step is to divide the infrahyoid muscles and remove the lateral lobe of the thyroid in the side on which it is proposed to approach the growth thus exposing the trachea and œsophagus. The œsophagus is then defined and tape passed round it to act as a tractor If there is hope of preserving the larynx the recurrent nerve should be defined and allowed to come forward with the larynx If the growth is in the lateral wall of the pharynx the œsophagus need not be isolated. In epilaryngeal growths the œsophagus need not be isolated when the growth can be removed by a conservative operation but this step should be taken if a laryngo-pharyngectomy is contemplated

The next step is to remove the ala of the thyroid cartilage and the corresponding half of the hyoid bone

Before proceeding to this part of the operation the operator must have in mind the relative position of the structures which he will meet

after removing the ala of the thyroid (Fig 768) The object of the operation is to display the outer surface of the pharynx without opening it As a first step the origin of the inferior constrictor from the posterior margin of the thyroid cartilage should be inspected If growth is present in this situation the case is unsuitable for conservative resection and can be dealt with adequately only if the operator is prepared to resect the larynx together with the growth Even so it is worth proceeding with the lateral exposure of the pharynx as this is the only means of exposing the growth adequately and making sure of its extent If the lateral lobe of the thyroid has not been removed the ala of the cartilage is exposed by mobilizing the lobe of the thyroid gland and turning it forward after dividing the corresponding infrahyoid muscle. Extensive growths will sometimes be found to have perforated the cartilage and involved the lobe of the thyroid This again is an indication that nothing short of complete laryngectomy is adequate

The posterior border of the thyroid cartilage is exposed by gently scratching the inferior constrictor from it and pushing away the mucosa from its inner surface This part of the operation must be done very gently in order to avoid injuring the mucosa. The attachment becomes closer as the operator approaches the midline and it is better not to attempt to remove the whole of the ala and to divide the cartilage with fine bone-forceps a quarter to a half an inch behind the midline

The hyoid bone is next separated by blunt dissection or diathermy from the thyrohyoid muscle and membrane and from the middle constrictor of the pharynx and the greater cornu with half the body of the bone is removed.

This completes the exposure of the lateral wall of the pharynx The subsequent steps consist in palpating the growth through the intact mucous membrane opening the pharynx through a portion of its wall which is not infiltrated and excising the growth with an adequate margin These steps are considered in the section of this article dealing with individual growths

Closure.—In conformity with Trotter's later practice no attempt should be made to obtain complete closure even in cases where it has been necessary to remove only a small area from the lateral wall of the pharynx

The edges of the skin flaps should be united to the divided mucosa of the pharyngeal wall wherever it is possible to do so without tension It may be necessary to leave a granulating surface between the skin edge and the margin of the defect in the pharynx where approximation cannot be achieved without tension but this is of no importance provided that the great vessels of the neck are adequately covered A pharyngeal tube is inserted through the mouth or nose and passed on by manipulation through the fistula for feeding purposes and the wound is dressed with petroleum jelly gauze.

Recent experience suggests strongly that attempts at primary closure are justifiable much more often now than they were in Trotter's time Control of sepsis has made spreading infection in the planes of the neck very rare and has at the same time made it possible to perform operations which are based on the fact that in the absence of sepsis epithelium grows very rapidly in the upper respiratory and gastro-intestinal tracts. Thus primary closure is now often attempted, the defect in the pharynx being closed by direct suture or by Thiersch grafts supported on fascia or tantalum gauze. If pedicle skin flaps are used the operation must necessarily be a staged one designed to form a temporary fistula

Tracheotomy in lateral pharyngotomy—Trotter insisted on preliminary tracheotomy to ensure safety during administration of the anæsthetic and to check aspiration of septic material to the lungs. Under modern conditions it is possible to carry out the operation under anæsthesia administered by the intratracheal route and many anæsthetists prefer this to administration of an anæsthetic through a tracheotomy opening From the operator s point of view it has the advantage of allowing him to change his plans more easily if at some course in the operation he decides that a laryngectomy is necessary If the anæsthetic is given through an intratracheal tube it is advisable to perform a temporary tracheotomy as the last stage of the operation in order to avoid respiratory obstruction in the few days following operation. The tube may be removed from the temporary tracheotomy on the second or third day

Closure of fistulæ following lateral transthyroid laryngotomy—These fistulæ differ so much according to the tissue removed at the primary operation that it is impossible to give a formal account of their closure. Closure should not be attempted until all granulating tissue has epithelialized and by this time the extent of the fistula will be found to have diminished very greatly In Trotter s hands closure was often achieved by selecting hairless skin round the margin of the pharyngeal defect and turning it in This method often leaves a good deal of scarring and there is less deformity if closure is achieved by the use of pedicle grafts obtained from a distant source. Whichever method is used, closure of fistulæ is tedious and quite commonly some temporary leakage occurs after closure has been attempted thus closure by local flaps is preferable if a reasonable functional result can be obtained without prolonging hospitalization to the extent which is necessary for closure by pedicle flaps obtained from a distant source. In this connection it is necessary to remember that removal of the growth alone places a severe strain on the physical and mental stamina of the patient and it is a matter of considerable urgency to return him to normal life with as little delay as possible Closure of small residual fistulæ and correction of deformities caused by scarring should be left until there is good reason to suppose that the risk of early recurrence is past

Detail of Treatment of Growths in Various Sites

Note —Where reference is made to interstitial irradiation in the following section it is assumed that the needles used are approximately of the strength dimensions and linear intensity recommended on pages 1824 to 1825 For needles which differ markedly from this specification the technique described is completely unsuitable

Carcinoma of the lip —For purposes of treatment all malignant growths of the lip may be included in a single group as their clinical course and reaction to treatment show little variability Nearly all these growths are squamous-celled carcinomata Attempts have been

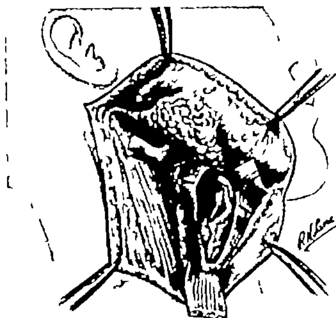


Fig 759 —Transthyroid pharyngotomy exposure completed

The submaxillary gland has been turned upwards with the upper skin flap and the digastric muscle has been divided The right half of the hyoid bone and the thyroid cartilage have been excised. The pharynx has been opened behind the cricoid and the cricoid with the larynx has been rotated forward The growth is seen in the post-cricoid space.

made to differentiate them according to their microscopic structure but results have been disappointing and Eckhert and Petry* reviewing a microscopic study of over 400 cases state that grading by Broder s method is not useful for determining the kind of treatment to be given or in making a prognosis

Carcinoma of the lip remains localized for long periods and a large proportion of growths presenting for treatment take the form of an ulcer less than half an inch in diameter with little surrounding infiltration and no evidence of metastasis Lesions of this type may be treated by operation by X rays by radium applied interstitially or

by tele irradiation. There is little to choose between the results which are uniformly good and in the region of 90 per cent five-year cures Operation relieves the patient of the lesion more quickly and on the whole with less worry and discomfort and is generally to be preferred

Large growths involving a third or more of either lip and those showing more widespread infiltration outside the ulcerated area should be treated in the first instance by irradiation and operated on subsequently if the irradiation fails to produce a cure

Operation is always to be preferred in very small lesions in which the clinical diagnosis of carcinoma is uncertain as a biopsy is necessary in any case and complete excision including an adequate margin of normal tissue is an operation which carries no danger and leaves no significant deformity while allowing a completely satisfactory biopsy Lesions which have failed to heal as a result of radiotherapy should be submitted to operation without hesitation following the general rule laid down by Paterson * that persistent and recurrent growth in previously irradiated tissues are resistant to further irradiation

Technique of interstitial irradiation.—The shape of the lips lends itself to a simple arrangement of needles and experience has shown that in a typical case it is unnecessary to irradiate widely beyond the visible margins of the growth A single-plane implant extending for three-quarters of a centimetre in all directions from the visible and palpable margins of the growth is sufficient

Surface application of radium carried in a mould which may be of the sandwich type can be used for most carcinomata of the lip It is generally rather more trying to the patient than interstitial irradiation

Tele irradiation is more suitable for cases in which induration is widespread and the margin ill defined

Operation—This may be purely local or may combine the attack on the lip with treatment of the glandular areas The diathermy knife should not be used as it may lead to failure of primary union Local operation is the correct treatment for small lesions in which the diagnosis is uncertain As an alternative to interstitial irradiation in typical cases it is entirely justifiable and a surgeon who does not work constantly with radium will attain better results with the knife

The old fashioned V-shaped incision is theoretically unsound but owing to the comparatively benign nature of the growth it is generally successful in small growths An alternative method is to make the incisions on either side of the growth diverge from one another for the first 2 or 3 cm. and then converge again below for convenience in closure (Fig 760a.) In both these methods the whole thickness of the lip is removed and hæmorrhage may be temporarily controlled by the fingers of an assistant compressing

* Cancer of the Mouth, *Postgrad. Med. Journ.*, 1941 xvi, 89-96.

the coronary vessels A margin of 0 75 cm on either side of the obvious limits of the growth on the red margin of the lip should be allowed In most cases direct closure of the defect by accurate suture of the skin and mucosa gives a sufficiently good result and it is well to remember that the tissues of the lip stretch very easily so that an operation which appears at first to leave an ugly deformity with a tight lower lip may show a result which is almost perfect a year later Operations which involve a great loss of tissue may require plastic repair Many operations have been devised and described to serve the purpose Lateral incisions extending either straight out wards or outwards and downwards from the apex of the V or from the lateral extremities of the diamond left by the primary excision

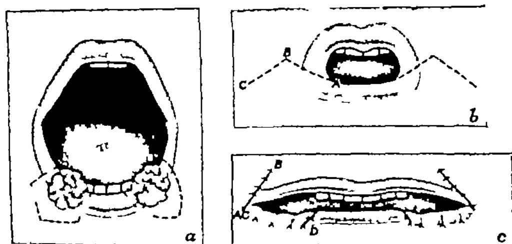


Fig 760

incisions for local removal of epithelioma of lower lip b, an epithelioma has been excised from the lower lip. Primary union has been obtained, but the narrowing of the lower lip has produced an ugly pouting deformity of the upper lip c, plastic repair Incise the full thickness of the lip along A, B, C. Unite A, B to B, C. This straightens the upper lip but leaves raw margin A, D along which the skin and mucosa are united by direct suture to form the lateral part of the lower lip.

release tension enough to allow the cut edges to be united but the narrowing of the mouth may still produce an ugly pouting deformity of the upper lip (Fig 760b) This deformity may be relieved by using Nelaton s method which is sufficiently indicated in Fig 760b and Fig 760c

Most surgeons at the present day consider that it is wrong to com bine immediate plastic repair with any primary operation for malignant disease which involves considerable loss of tissue In operations for malignant disease excision of an adequate margin of apparently normal tissue is the primary consideration and it is well that the surgeon s mind should not be distracted from this by the necessity for considering means of repair Furthermore recurrence of growth in a wound which has been repaired at the expense of the surrounding tissues is very difficult to treat and from this point of view also it is better to delay plastic repair until sufficient time has elapsed to show that the excision has been sufficiently radical. In some cases it will be

found that even after a very extensive excision the patient suffers so little discomfort that he prefers not to submit to any further operation.

Treatment of glandular areas in carcinoma of lip —Recurrence of growth between the primary lesion and the glandular areas is uncommon and it is generally better not to attempt operations combining the treatment of the two However such operations do not carry the same mortality in the lip as they do in the tongue and if it is thought desirable the lower end of the wound left by the primary excision may be extended into the submaxillary triangle so as to make it possible to remove the tissues of the submaxillary triangle and the growth together with the strip of deep fascia uniting them. If this is done it is better not to incise the mucous membrane of the lip until the end of the operation so as to avoid the possibility of contaminating the tissues of the neck with septic material from the mouth Figures obtained from various sources give very different pictures regarding the likelihood of the presence of lymph node metastases at the time at which a carcinoma of the lip is treated. Palpability is a very poor indication as the lymph glands in the submaxillary triangle are palpable in a large proportion of normal adults.



Fig 761

A patient from whom extensive growths of the upper and lower lips had been removed two weeks before the photograph was taken The growths had been treated previously without success by irradiation More than half of the lower lip was removed and rather less than half of the upper lip No attempt was made to reduce the deformity by plastic repair.

The only sound means of deciding whether a gland dissection should be carried out after treating a carcinoma of the lip is by surveying the after history of a series of cases in which no treatment has been given. A survey of these figures suggests that about 80 per cent of patients in whom the gland areas are not treated never develop metastases but everyone who has treated large numbers of cases of carcinoma of the lip has observed the development of the metastases after the cure of the primary growth and it is generally agreed that patients who cannot be kept under observation should be submitted to operation for removal of the nodes whether they are palpable or not. If close observation is possible most surgeons are content to remove the nodes only if they show clinical evidence of involvement i.e. if nodes appear in the course of observation or if pre-existing nodes become larger and harder It is similarly agreed that direct involvement of the deep cervical nodes in carcinoma of the lip is extremely rare and if operation is undertaken either before there is clinical evidence of involvement or

in the very early stages of clinical involvement it is sufficient to clear the suprahyoid portion of the neck. It must be noted that the lymph nodes which lie between the anterior bellies of the digastric muscles in the fatty tissues superficial to the mylohyoid are more likely to be involved in carcinoma of the lip than in any other growth in the mouth. This area is not always cleared even when a bilateral radical dissection is done and it requires special attention in cases of carcinoma of the lower lip.

Carcinoma of the floor of the mouth.—Growths which come under this heading are fairly constant in position and type. They generally start in the region of the orifice of the submaxillary duct and tend to spread laterally over the alveolus and upwards into the substance of the tongue so that in many cases the tongue, when fully protruded, is dimpled over the growth. They have no marked tendency to widespread glandular involvement and, as Butlin noted many years ago, they are much more amenable to treatment than their formidable appearance suggests. Estimates of the five year survivals vary widely. The correct figure is probably about 40 per cent. if a very large series of cases be taken, but there are several available records which show results much better than this.

Choice of treatment.—Being of relatively low malignancy, these growths are capable of cure either by irradiation or by operation. Satisfactory irradiation of large growths is difficult for three reasons. These are: (1) The growth is close to the compact bone of the lower jaw and any case of carcinoma of the floor of the mouth which has been cured by irradiation may subsequently develop a necrosis of the lower jaw. This event may occur many years after irradiation. Necrosis cannot be avoided with certainty by any known precautions. (2) Access to large growths in the floor of the mouth for interstitial irradiation is difficult, particularly if the lower alveolus is well developed. (3) All growths in the floor of the mouth are in very close relation to the lymphatic tissue in the submaxillary triangle and unless the growth is very superficial it is impossible to treat it adequately by irradiation without irradiating also the tissues of the submaxillary triangle. It is extremely difficult to perform a satisfactory gland dissection on a submaxillary triangle which has been fully irradiated, and if an infiltrating growth in the floor of the mouth is treated by irradiation the glands of the submaxillary triangle cannot be excised subsequently. Small superficial growths can be irradiated without encountering any of these difficulties.

Operations for growths in the floor of the mouth are satisfactory only if they are planned and carried out as a major procedure designed to remove the growth together with its lymphatic extensions in the submaxillary triangle. This involves dividing the jaw and laying open the cavity of the mouth into the tissues of the neck. The operation is one of considerable severity but it does not carry a high mortality. Limited operations carried out from within the mouth are unsatisfactory

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in carcinoma of the floor of the mouth as it is impossible to expose the lesion adequately while it is protected by the bone of the lower jaw

Thus operation should not be undertaken for small superficial lesions which can be well treated by irradiation leaving the treatment of the gland areas as a separate problem

Large growths in which there is obvious involvement of the compact bone of the lower jaw demonstrable by X rays are quite unsuitable for any form of irradiation and should always be treated by operation Between these two classes there comes a large proportion of cases of carcinoma of the floor of the mouth which are better treated by operation in suitable cases but may be treated by irradiation if operation appears to involve too much risk to life These cases comprise those in which bone involvement is present but not gross and those which extend far back in the floor of the mouth involving the tissues of the submaxillary triangle

Cases which show metastases in the submaxillary triangle when they first report for treatment are better treated by irradiation if the aim is palliation and by operation if complete cure is the object of the treatment *Complete cure should not be aimed at if the history is* short and the glandular involvement extends beyond the submaxillary triangle as operation in such rapidly advancing cases is likely to lead to diffuse recurrence in the neck. If on the other hand, metastases are widespread but of a slowly growing type there is a reasonable *prospect of cure by operation if a complete gland dissection is carried* out In these circumstances the operation for removal of the glands becomes the primary consideration and any form of irradiation which renders the tissues in the submaxillary triangle unsuitable for operation must be avoided.

Technique of irradiation for carcinoma of the floor of the mouth.— Small superficial growths can be treated successfully by surface application of radium on an intra-oral applicator This is not suitable for more bulky lesions which have extended into the tissues of the *floor of the mouth and in these it is necessary to reinforce* the internal applicator by interstitial or tele-irradiation Cases in which the growth has extended upwards and involved the tongue cannot be treated by applicators alone and if irradiation is to be used it must be either by tele-irradiation or else by interstitial irradiation with or *without a reinforcing applicator*

Before embarking on any form of irradiation for carcinoma in the floor of the mouth it is essential that all teeth in the lower jaw should be extracted. The reason for this precaution is that it is impossible to irradiate a carcinoma in the floor of the mouth without impairing the *nutrition of the lower jaw enough to make it likely to sequestrate* if teeth are extracted subsequent to the irradiation Even with the use of all possible precautions I have seen two of my own cases cured of growths in the floor of the mouth return with spontaneous necrosis

of the lower jaw one six and the other seven years after treatment The complication is an extremely distressing one and may even be fatal and the fact that it cannot be avoided with certainty limits the use of irradiation in this area

Fig 762 shows a type of applicator used for intra oral surface application of radium In this case the growth was a superficial



Fig 762 —Applicator for surface irradiation of right lower alveolus.

A, applicator viewed from the front The large compartment XX accommodates the tongue and the left lower alveolus Radium is carried left in the portion YY which lies over the growth The unaffected parts of the mouth are protected mainly by the arrangement of the upper which ensures that they are kept a distance from the radium B Lateral aspect The chamber which contains the tongue and the left lower alveolus is lead lined *Photo by Bryan Stanford*

one involving the lower alveolus and not the floor of the mouth but a similar type of apparatus is suitable for superficial growths in the floor of the mouth

Interstitial or combined irradiation has become much more satisfactory since the introduction of perspex jigs With these it is possible to attain much greater accuracy in the placing of interstitial needles and their relation to surface applicators A growth in the floor of the mouth requiring combined treatment by an internal applicator and interstitial needles may be well treated by an apparatus similar to that shown in Fig 749 p 1828 If this apparatus is adapted for combined intra-oral surface irradiation and interstitial irradiation the upper plate carries the radium necessary for the surface application It is hinged in front of the jaw to the lower plate which is made with thick perspex which has been drilled to admit the needle for interstitial irradiation As these needles pass through channels in the thick perspex applicator it is possible for them to enter only the tissues in line with the channel The calculation of dosage and the placing of the interstitial needles in relation to the surface applicator is an intricate physical matter and treatment of this type should be attempted only with the aid of a physicist The external portion is used only during the insertion of the interstitial needles The internal portion is worn for eight hours in the twenty four over a period of seven days

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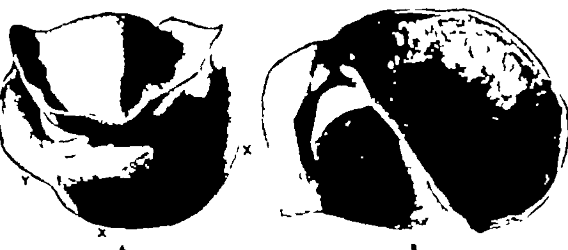


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Lesions in this situation are not suitable for interstitial *irradiation* by needles inserted through the mouth as the area immediately behind the alveolus is very inaccessible. Radon seeds can be used but it is very difficult to insert them accurately

Growths showing evidence of widespread involvement of the lymph nodes are best suited to palliative irradiation from a distant source but can also be treated by a combination of interstitial and surface irradiation

Irradiation of a growth in the floor of the mouth by any means may be followed by fibrosis obstructing the duct of the submaxillary gland and it is sometimes necessary to excise the gland because of the painful swelling which is produced.

Operation —Very small growths may be excised from within the mouth if irradiation is not available but the difficulties of access are considerable and the operation is unsatisfactory if the growth is close to the lower jaw or infiltrates tissues below the submucosa. For superficial freely movable ulcers diathermy may be used either for *coagulation or for excision but the possibility of secondary hæmorrhage* and the difficulty of controlling it in this situation must not be forgotten It is better to expose the growth fully by removing a portion of the alveolus without dividing the whole thickness of the jaw and to excise it either by knife or diathermy point The raw area left can be covered with an inlay graft as described on p 1859 and if this is done the sulcus between the tongue and the jaw will be preserved and the patient will be able to wear dentures without discomfort The submaxillary duct is inevitably divided or injured but no steps need be taken to reconstitute the opening

For larger growths the best means of approach is by lateral division of the jaw In a few cases the growth can be excised after approaching it by Kocher s median approach (*see* p 1840) without disturbing the tissues of the submaxillary triangle but growths requiring this type of operation generally involve either the bone of the lower jaw or the tongue or both and in such cases the operation is not adequate unless it includes clearance of the submaxillary triangle A curved skin incision is used extending from the mastoid process down to the level of the hyoid and upwards and forwards to the symphysis menti Before dividing the jaw a flap consisting of skin subcutaneous tissue and platysma is turned up far enough to expose the facial vessels where they cross the lower border of the jaw and the lymph gland which lies on them at this point The vessels are then divided distal to the gland and the deep fascia incised along the lower border of the jaw as far forward as the mid line Returning to the posterior part of the wound the facial vessels are isolated and divided between the posterior belly of the digastric muscle and the submaxillary gland The digastric muscle is divided posteriorly and turned forward together with the submaxillary gland as far as the posterior border of the mylohyoid The hyoglossus is now exposed and the hypoglossal nerve may be defined and the lingual artery ligatured The capsule

of the submaxillary gland and the digastric tendon are freed from the hyoid bone and turned upwards on the mylohyoid The posterior part of the wound is packed with gauze soaked in flavine and returning to the anterior part the growth is reviewed and a decision is made as to whether it is necessary to remove any part of the jaw The site of division is dictated by this decision and the jaw is either divided just to one side of the middle line after separation of the muscles from its inner aspect or the involved segment is isolated by division on either side of it

The mylohyoid is now divided between the jaw and the hyoid the actual site of division being again dictated by the extent of the growth and the posterior end of the growth is exposed by pulling the divided half of the jaw outwards on the affected side and freeing the mucosa from it as it is retracted The lingual nerve and the mucous membrane of the floor of the mouth are divided behind the growth which is turned forward together with the deep part of the submaxillary gland and the sublingual gland This leaves the growth attached by its inner border to the side of the tongue and owing to the characteristic mode of extension it is often necessary to remove a portion of the tongue with it There is no objection to doing this and it may actually be an advantage in the subsequent closure of the floor of the mouth

Closure after this operation involves reconstruction of the mucous lining and as far as possible of the musculature of the floor of the mouth The ease with which it is attained depends on the amount of tissue removed but in most cases the mucosa of the tongue can be freed and drawn across to meet the lower jaw so that by suturing carefully from behind forwards and apposing raw surface to raw surface rather than edge to edge very fair results can be attained

Tissues which are sewn together under tension inevitably break apart and if there is difficulty in making the edges of the mucosa meet tension stitches may be inserted through the substance of the tongue and carried round the lower jaw to be tied externally These stitches tend to become loose by cutting into the tongue in a few days but in the immediate post-operative period they serve both to relieve the tension on the suture line and to prevent the tongue from dropping back into the pharynx which it is apt to do as a result of the division of its anterior attachments

If it is desired to leave the patient able to wear a lower denture it is better to apply an inlay epithelial graft instead of attempting direct closure of the mucosa This is done after uniting the jaw by moulding a piece of Stent s composition to the shape of the raw area in the floor of the mouth and wrapping it up completely in a thin Thiersch graft taken from the thigh the raw surface of the graft being outward The wrapped Stent s is then dropped into place in the raw area and encircled by large stitches which hold it firmly in position These inlay grafts take very readily in the mouth and if the Stent s is removed on the fifth or sixth day the epithelium is usually firmly adherent

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If no portion of the jaw has been removed the divided ends are united with silver wire If it has been necessary to remove a portion of the whole thickness of the bone a deviation of the chin to the affected side results Attempts may be made to prevent this by dental appliances but they are not generally satisfactory and it is better to allow healing to take place and to undertake subsequent plastic operation if necessary The skin flaps are loosely united and drainage is provided as far up as the reconstructed floor of the mouth.

This operation is designed not to encroach on the carotid sheath so as to leave the field open for subsequent dissection of the deep cervical nodes at a separate operation if it is required.

Operations of this type designed to remove the growth and clear the glandular areas at one sitting were at one time condemned as unsound because of their high primary mortality and the risk of severe sepsis but under modern conditions they are reasonably safe and are the best means of dealing with a growth in the floor of the mouth which has infiltrated the glands of the submaxillary triangle.

Carcinoma of the lower alveolus.—Paterson* gives a 48 per cent five-year survival rate for cases of carcinoma of the alveolus treated by irradiation when no metastases were present in the lymph glands The percentage falls to 86 per cent. in cases with involved glands. New† gives corresponding figures of 70 per cent and 29 per cent. for cases treated by surgery There is of course no certainty that these figures refer to corresponding series of cases.

Technique of irradiation.—The technique recommended from the Holt Radium Institute for irradiation of alveolar growths consists of a mould which carries radium and is worn intermittently These moulds are very uncomfortable to wear and are difficult to keep in place. Nuttall‡ estimates that an error of a ½ mm. makes a 10 per cent. error in dose

I have been accustomed to treat alveolar growths by excision. A careful distinction must be made between papillary growths and those which infiltrate the jaw deeply without producing any marked external change The papillary growths do not require an extensive removal of bone. The operation is generally very well tolerated and I have carried it out successfully on a patient of well over 90 years of age. The infiltrating type requires a wide excision of bone but even so the operation involves little danger as there are seldom any severe septic complications. The infiltrating type is quite unsuitable for irradiation.

Operation.—Papillary growths are best approached from inside the mouth If necessary the cheek may be split as described on p 1887 The mucous membrane is first incised a full half inch away from the margins of the growth so as to surround it completely Diathermy is helpful in this part of the operation as the absence of oozing which

* *Postgrad. Med. Journ.*, 1941, XVII, 60–66
† *Trans 41st Annual Meeting, Amer Laryng Rhinol Otol Soc* 1935, pp 610–13
‡ *Brit. Journ. Radiol.*, 1943 XVI No. 183.

attends its use makes it easier to define the margins of the growth. The mucosa is dissected up towards the affected part of the alveolus and the operation is completed by removing a segment of the bone with a gouge or chisel.

Growths of the infiltrating type should be studied carefully before operation as they often extend more widely than their superficial appearance suggests. Particular attention must be paid to expansion of the body of the jaw and to X-ray appearances. These growths must be approached by an external incision along the lower border of the jaw, and the only chance of success is an unhesitating sacrifice of as much bone as is necessary to leave a margin of half an inch or more from the obvious limits of infiltration. Attempts at sparing the bone to avoid deformity are certain to end in recurrence, and the jaw must be divided behind its angle if this appears necessary. As ulceration is not a prominent feature of these growths, sepsis is less formidable than in many other mouth operations, and it may be justifiable to insert a bone graft between the fragments of the jaw at the time of the primary excision. It is not worth making this attempt unless it is possible to close the mucous membrane accurately over the graft, and even so the graft is generally absorbed sooner or later. The disability which results if no attempt is made to replace the lost bone is not severe.

Glandular invasion is not a prominent feature of the infiltrating type of growth. Both in the infiltrating and the papillary type treatment of the glandular areas is a separate problem, and should be dealt with on the lines laid down on p 1894.

Carcinoma of the upper jaw.—Papillary growths which are limited to the alveolar margin may be treated by irradiation from a mould. A few small spongy sequestra generally result. They do not influence the course of the recovery and are of no serious significance, but the discomfort which the patient suffers is probably greater than that of operation. Irradiation should not be used for growths at the posterior extremity of the upper alveolous as the ascending ramus of the lower jaw is very close and cannot be protected.

Operation.—For a small growth it is best to start by marking out the limits of the proposed excision with the diathermy knife. Mucous membrane incised in this way does not bleed, and consequently makes it easier to be sure that an adequate margin of normal tissue has been included. The diathermy incision is carried down to the bone. It is always wise to remove the part of the alveolus which lies beneath the growth, and this is best done by dividing it with a sharp chisel. The mucous membrane of the maxillary antrum may be exposed, but if possible it is left intact and subsequently inspected to make sure it is not involved in the growth. Cases which are suitable for this operation do not require removal of the bone of the hard palate. If this is involved the whole excision must be planned on more generous lines.

The immediate results are very satisfactory when performed on suitable cases Sepsis is not marked and the raw surface epithelializes rapidly so that in a few weeks a dental apparatus can be fitted to cover the defect In cases where there is wide involvement of the alveolo-buccal sulcus an inlay graft (*see* p 1859) should be used. The most usual cause of disappointment is failure to realize the extent of the growth so that an apparently successful local excision is followed by recurrence before healing is complete The lymphatic drainage of this area is mainly in a posterior direction in accordance with the vascular supply and it is generally in the posterior part of the wound that recurrences originate It is therefore essential for the surgeon to assure himself as far as possible that the growth really is a limited one before he plans and undertakes a limited operation.

Extensive growths of the upper jaw —*There are three types of* extensive growth in the upper jaw and each has its own appropriate treatment.

(1) **Growths which tend to spread widely and deeply with comparatively little ulceration.**—This is the type in which the extent of the growth is inferred by the presence of such signs as pain of trigeminal distribution and ophthalmoplegia, rather than by direct physical signs These cases are quite unsuitable for operation. Like many other growths which extend beneath the mucous membrane without ulceration they are highly radiosensitive and may be greatly improved by irradiation During the period of improvement which may last a year or two pain and paralysis may disappear entirely and the local condition return to normal. These growths have many points in common with submucous infiltrating growths of the naso-pharynx and posterior *third of the tongue and like them they have a strong* tendency to ultimate uncontrollable metastasis and five-year cures are uncommon

Interstitial irradiation should *not* be used in this type of case if tele-irradiation is available The complicated anatomical structure of the part and the irregular extension of the growth among the bones at the base of the skull make it very difficult to distribute needles evenly and it is possible that the introduction of infection which is inseparable from numerous needle punctures reduces the radio-sensitivity of the growth. Teleradium is probably more suitable than X ray therapy Fig 768 shows the result of treatment in a case of this type.

(2) **Ulcerating growths originating on the alveolus or palate or in the alveolo-buccal sulcus**—The classical operation of excision of the upper jaw modified to suit the requirements of each particular case should be used for these growths. The operation is a considerable one but rarely produces much shock As drainage is necessarily free from the beginning severe sepsis is rare and neither coughing nor swallowing is interfered with enough to predispose to pulmonary complications. By suitable modifications of the classical operation a very good facial contour may be preserved and as it is rarely necessary to

remove the floor of the orbit there is no interference with binocular vision The classical operation suitably modified gives good results in growths involving the upper jaw from its external surface

(3) **Growths originating in the antrum** —If the classical operation is used for these growths it is necessary to include the floor of the orbit in the excision This inevitably interferes with binocular vision



A B

Fig 763.—Submucous infiltrating tumour of upper jaw
A before treatment; B si[illegible] weeks later after mass irradiation.
(Reproduced, by permission, from *Lancet* March 25th, 19[illegible])

and most surgeons agree that when it is necessary to excise the whole of the upper jaw it is better to clear the corresponding orbit as well In antral growths the operation is rarely justified because the poor results which it produces do not justify the extensive mutilation

Most surgeons prefer now to use limited operations to provide free drainage and to expose the growth and to employ either interstitial or tele irradiation to arrest its progress The long term results in true antral growths are bad and it is possible that in the future it will be found that extension of the classical operation to include the pterygoids gives results which are sufficiently good to justify the mutilation.

The eye is very easily damaged by irradiation and when irradiation is employed in the upper jaw the patient should be warned that the sight of the corresponding eye may be damaged or even completely destroyed

Steps of the Operation for Removal of Upper Jaw

Preliminary ligature of the external carotid artery is an advantage If this is not done bleeding may be very free and although it is not often enough to endanger life it is sufficient to obscure the operative field and lead to difficulty in adhering to the original plan of the operation. Even when the external carotid has been ligatured hæmorrhage is very free The usual procedure is to ligate the

external carotid artery at the time of the main operation but an alternative plan must be followed if the deep cervical glands are already involved. Fortunately such involvement is rare but if it is present a radical gland dissection must be done the external carotid artery being ligated in the course of the operation The jaw must be excised as soon as possible after the gland dissection as collateral circulation is very rapidly established

The skin incision follows the classical lines by dividing the upper lip and following the boundaries of the nose so far as the inner canthus. At this point some operators prefer to adopt Trotter s modification and carry the incision through the conjunctiva just internal to the margin of the lower lid, rather than through the skin of the lower lid itself (Fig 764) This is easily done by carrying the incision across the lower eyelid just lateral to the orifice of the lacrimal duct and introducing one blade of a pair of scissors into the loose subconjunctival tissue at this point. This modification is not necessary if the growth is one which allows the operator to spare the bone of the orbital floor If the whole upper jaw is to be removed it may minimize the ugly deformity which results from the interference with the lymphatic drainage of the lower lid which the classical operation produces. From the outer canthus the incision is carried an inch or so downwards and outwards through the skin of the cheek down to the bone and a flap consisting of the whole thickness of the cheek is prepared. As this flap is turned back the mucous membrane of the gingivo-buccal sulcus is cleanly divided well away from the margin of the growth



Fig 764.—Incision for removal of the upper jaw (Trotter s modification)

The incision follows the classical lines except that along the lower lid it is carried through the conjunctiva instead of the skin.

Returning to the medial part of the wound the cartilage of the nose is separated from the nasal margin of the maxilla. The subsequent steps of the operation depend on the extent and nature of the growth. If there are signs such as expansion of the jaw or infra orbital pain which suggest wide involvement of the antrum it is best to follow the classical procedure and to free the upper jaw intact by elevating the periosteum of the floor of the orbit and dividing in turn the malar and frontal attachments of the bone and dividing the hard palate in the midline either with a key hole saw through the nasal cavity or a mechanical saw through the mouth. The soft palate on the affected side is freed from the hard palate by an angled diathermy point thus joining the incision in the midline of the hard palate to that in the gingivo-buccal sulcus. This leaves the maxilla attached posteriorly to the pterygoid laminæ from which it should be gently separated by a curved periosteal elevator introduced from behind on the outer side Attempts to seize the bone and twist it out without

dividing its posterior attachments should be avoided as they usually result in crushing the walls of the antrum if they are invaded by growth and involve the risk of implanting carcinoma cells in the raw tissues of the wound As the jaw is separated the maxillary nerve is usually drawn out with it and should be divided far back Hæmorrhage is considerable for a few moments whether or not the carotid artery has been ligated and is best controlled by plugging The skin incisions should be accurately sutured as healing by first intention can generally be obtained but the facial contour is marred by the sagging of the tissues of the cheek and the consequent displacement of the eye Various methods have been suggested for overcoming this difficulty (such as the provision of a sling fashioned from the temporal muscle passing from without inwards beneath the periosteum of the orbit) but none of them is very satisfactory and patients on whom the classical operation has been performed generally have to wear an eye shade In dealing with growths which do not invade the antrum widely it is often possible to spare the upper bony wall of the cavity This can easily be done by dividing the bone across the frontal process from the upper end of the nasal cavity and prolonging the line of division outwards just below the orbital margin The bone is thin and cuts easily with a dental burr mechanical saws are too powerful and not sufficiently accurate The incision is prolonged outwards into the zygoma and then turned downwards at the outer angle of the orbit The mucosa of the antrum is then gently elevated from the under surface of the orbital floor and a chisel inserted directly backwards between the mucosa and the orbital floor divides the thin bone of the posterior antral wall If this can be done the cosmetic result is greatly improved and after provision of a suitable denture there is little visible deformity

Removal of the eyeball —When there is definite involvement of the orbit as shown by displacement of the eye and infra-orbital anæsthesia it is certain that no operation can be curative without sacrifice of the eyeball Many surgeons now believe that the eyeball should be removed in all cases in which it is not possible to spare the orbital plate partly because an eye which has been left *in situ* after resection of the upper jaw is generally both unsightly and useless and partly because the presence of the eye is an embarrassment to the radiotherapist if subsequent treatment of the cavity by irradiation becomes necessary If the orbit is to be cleared the removal of the maxilla should be combined with that of the malar bone and complete exenteration of the orbit The operation is little more serious than the classical excision of the upper jaw and its results in suitable cases are better The resulting deformity is easily concealed by an ordinary eyeshade

Irradiation for carcinoma of the upper jaw —For growths in which the limits of the extensions can be appreciated by sight and touch interstitial irradiation may be used though it involves considerable risk of necrosis In such cases needles inserted horizontally

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on the inner side of the ascending ramus of the mandible may be used to inhibit the posterior extensions while the main mass of the growth is treated by needles on the surface of the jaw If necessary needles may be inserted through the soft bone of the alveolus to irradiate the substance of the jaw as the bone is very light and massive sequestra do not form Neither the palate nor the tissues lying in front of the angle of the lower jaw are easy to irradiate by the interstitial method because of the small depth of tissue available to carry the needles. Cases in which there is a great deal of destruction of bone are ultimately hopeless and palliative results are better with teleradium than with the interstitial method In cases with marked glandular involvement the glands along the course of the external maxillary artery are generally invaded. If they are to be treated at all tele irradiation should be used with a view to including the lymphatic nodes along the external maxillary artery

Thus the field for interstitial irradiation in extensive growths of the upper jaw is limited to those which spread superficially beyond the limits of the jaw but which show no strong tendency to glandular involvement or destruction of bone Here as elsewhere success depends upon uniform distribution of radium and the avoidance of irregular dosage Small sequestra must be expected in all cases of carcinoma of the upper jaw treated by interstitial irradiation but as the bone is light and the sequestra separate easily they give rise to little trouble.

The only way to attain uniformity in this very complicated region is to plan the details of the irradiation separately in every case and to carry it out with all the care which would go to a major operation If this is done in suitable cases interstitial irradiation can give very excellent results at the expense of comparatively little discomfort to the patient. Used indiscriminately and without attention to detail its results are very bad

Combinations of surgery and irradiation—If an antral growth is to be treated by irradiation it is advisable to reduce sepsis and perhaps to reduce the bulk of the growth by draining the antrum and removing fungating growth Antrostomy alone by providing free drainage reduces pain and sepsis and makes it possible to define the limits of the growth more accurately Many surgeons now treat these growths in the first instance by antrostomy and then by tele-irradiation The patient is re-examined six weeks after the tele irradiation has been completed and if any small residual areas of growth remain they are treated by interstitial irradiation Such supplementary treatment carries a considerable risk of necrosis It should not be used if there are signs that the normal tissues have reached or are near to the limit of their tolerance and in any case the total dose in a supplementary irradiation must be very small

An alternative to antrostomy is partial resection of the upper jaw leaving the orbital plate *in situ* followed by irradiation on lines similar

to those described above The deformity which results from partial excision of the upper jaw is not great and the cavity left is more easily inspected than that which results from antrostomy The preference of the writer is for partial resection of the jaw followed by irradiation On the whole antral growths are extremely malignant and the prospects of cure by any method are poor Any method which relieves sepsis and reduces the bulk of the growth relieves pain and produces a good palliative result for a time and it is very doubtful whether any significant increase in the cure rate would follow if partial resection of the jaw were generally adopted in the place of antrostomy but the cavity drains more freely and is more easy to inspect than that furnished by an antrostomy and is more accessible for interstitial irradiation of residual growth or recurrences

Carcinoma of the cheek.—Reference has already been made to the difficulty of distinguishing carcinoma from tuberculous ulceration in this region Carcinoma is very much more common but biopsy should always be made before the main treatment is commenced

In early or moderately advanced cases of carcinoma of the cheek interstitial irradiation is easy to carry out and gives excellent results The ulcer generally starts in the neighbourhood of the orifice of the parotid duct and spreads evenly from its centre producing a circular lesion While it is in this form a simple palisade arrangement of needles suffices to cause the disappearance of the lesion The needles should be placed deeply enough to lie in the plane in which obvious infiltration of the tissues of the cheek ceases and if this is done there is no necessity to risk necrosis of the skin by inserting a second layer Teleradiation presents no advantage over the interstitial method but if the services of a physicist are available growths of the cheek may be very satisfactorily treated by a sandwich applicator of the type shown in Fig 751 (p 1881)

Growths which start far back and those which have been neglected long enough to spread on to the alveoli or the front of the ascending ramus of the lower jaw do not give the same good results with irradiation and are better treated by operation

Operation —Small localized growths in the cheek may be excised from within the mouth More extensive growths are better approached by an incision running backwards from the angle of the mouth The steps of the operation for excision require no special description but it is essential that the margin of apparently normal tissue behind the growth should be adequate The parotid duct must generally be divided and its proximal end anchored to the posterior margin of the wound with a fine catgut stitch Whatever method is used there is necessarily a considerable sacrifice of mucous membrane and if the defect is too extensive to permit easy closure by suture an inlay graft should be used Suture of the mucosa under tension leads to trismus and should be avoided If the loss involves skin as well as mucosa, attempts at immediate plastic repair are inadvisable for the reasons

stated on p 1861 but it must be remembered that if no attempt is made to replace the lost epithelium trismus is certain to develop and the patient should be encouraged to use a wedge or a gag two or three times a day in the post-operative period

Diathermy is apt to cause necrosis of the skin and most surgeons in this country avoid it

Norman Patterson has described a method of excision which has the advantage of permitting diathermy for the removal of the growth

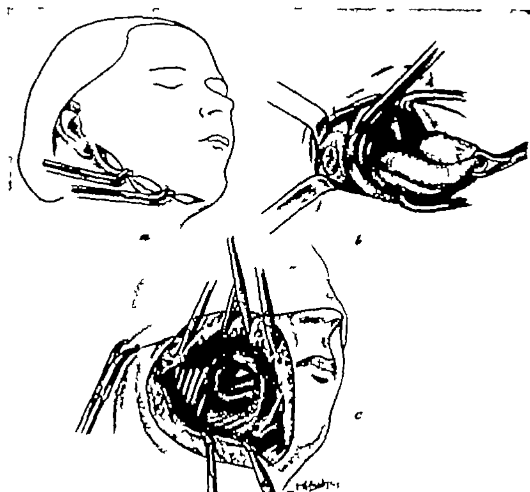


Fig 765.—Norman Patterson s method for excision of carcinoma of the cheek.

a, skin flap marked out b commencement of intrabuccal part of operation c, excision completed. The facial vessels have been removed between the mandible and the base of the flap and piece of the edge of the masseter has been removed The growth has been excised and the skin flap is ready for replacement.
(*Reproduced, by permission, from The British Journal of Surgery*)

itself without involving the risk of skin necrosis A flap is marked out consisting of skin only by an incision commencing at the pinna and following the posterior and lower border of the mandible as far as the midline. This flap is turned upwards far enough to allow complete exposure of the external aspect of the growth. The facial vessels are

then divided and excised from the point where they cross the mandible to that at which they disappear into the base of the flap so as to preclude the possibility of a later secondary hæmorrhage If it is necessary in order to secure an adequate exposure of the growth a part of the masseter and the ramus of the jaw is removed Having thus completed the exposure of the external surface of the growth Patterson gags open the mouth and excises the growth together with an adequate margin of normal tissue by diathermy working from inside the mouth The skin flap is then replaced and secured in position (Fig 7[illegible])

This operation necessarily destroys the greater part of the parotid duct in most cases but according to Patterson no untoward symptoms are likely to arise as a result

The method as originally described made no attempt at reconstituting the epithelial lining of the inner surface of the cheek and a wedge or gag was used by the patient until healing was complete

Carcinoma of the Tongue

Very wide divergences of opinion on the correct treatment for carcinoma of the tongue have existed for many years and the introduction of treatment by radium has increased rather than diminished the perplexities The fact that a number of different treatments are in use indicates that no one of them is entirely satisfactory and reference to the section of this article dealing with prognosis will show how very far we are at present from a satisfactory solution of the problem *The greatest measure of success will be obtained by the surgeon who familiarizes himself with all available forms of treatment and uses them discriminatingly according to the type and stage of the growth with which he is dealing* There are many cases to which several forms of treatment are applicable with almost equal prospects of success and in these the surgeon should choose the method with which he is most familiar There are others which should always be treated by radium if it is available and still others in which operation is the method of choice X ray treatment is seldom successful in the tongue and is inferior both to operation and to radium

The choice of radium or operation in the treatment of a localized primary growth has little influence on the survival rate provided that both are competently carried out In large growths the balance is somewhat in favour of radium but the five-year survivors are so few in either case that from this point of view there is not a great deal to choose between the methods Few advocates of operation for the primary lesion are to be found in recent publications though New* records a series of 162 cases treated by operation with an overall five-year survival rate of 87 2 Morrow† a 20 per cent five-year survival

* *Trans 41st Annual Meeting Amer Laryng Rhinol Otol Soc* 1935 p 610.
† *Ann Surg* 1937 CV No 3.

rate and Simmons* a 20 per cent. five-year survival rate Paterson† gives a 80 per cent. five-year survival rate for carcinoma of the anterior two-thirds of the tongue treated with radium to the primary lesion and operation when necessary for the glands of the neck and Berven‡ gives percentages varying from 82 to 20 per cent of five-year cures after treatment of the primary growth by various forms of irradiation followed in some cases by surgical excision or electro-coagulation

These figures necessarily refer to cases treated some time back. In the case of operative results it is fair to assume that present-day figures will show some improvement as the formidable operative mortality previously associated with combined operations on the neck and the tongue (about 50 per cent. according to Morrow reference above) has been very greatly reduced by improvements in anæsthesia chemotherapy and antibiotics. It is not clear that advances in irradiation technique have been followed by a similar improvement in results and the Radiumhemmet fitures indicate an opposite trend though this is probably due to a less rigorous selection of cases

The very striking constancy of the five-year survival rate by various treatments given under first-class conditions indicate strongly that the percentage of survivals is a factor of the nature of the disease in an average cross-section of patients at the time when they present for treatment rather than of the method of treatment. It must also be remembered that both sets of figures come from institutions enjoying every facility for the particular form of treatment on which they are reporting and that as the facilities required for the proper application of irradiation are more complicated than those required for surgery operation is likely to remain the method of choice in many parts of the world. Thus there is as yet no justification for a general abandonment of surgical methods

Cases in which operation should *not* be used are as follows —

1 Malignant tumours of the base of the tongue which show diffuse sub-mucous infiltration or are shown histologically to be highly anaplastic

2. Tumours which have given rise to rapid and widespread metastases from a primary growth of small dimensions.

3 Cases in which it appears likely from a full consideration of the situation nature and extent of the growth that an attempt at radical removal would cut across infiltrated lymphatics and thus expose the patient to the risk of a diffuse recurrence

4. It is doubtful whether it is justifiable to operate on an old patient if total removal of the tongue is necessary to achieve a fair chance of freedom from recurrence This is a relative contra indication and does not apply to old people who are still very active mentally or to younger people who are better able to adapt themselves to the resulting

* *Amer Journ Rhoent* 1931, V, 26
† *Postgrad. Med Journ.*, 1941 XVII 88–96.
‡ *Acta Radiol.*, 1937 XVIII.

deformity Most old people on whom a total glossectomy has been performed find great difficulty in swallowing without choking and in making themselves understood and in them the operation of total glossectomy is justifiable only if their mental make up is strong enough to stand up to the disability

Cases which should not be treated by irradiation are as follows —

1 Cases which have been previously irradiated and show a recurrence in tissue which has undergone a full irradiation Small marginal recurrences may come outside this category as their presence may mean that irradiation was not extended sufficiently widely

2 Cases in which the growth involves compact bone i e. if there is clinical attachment of the growth to the bone over a considerable area or if the bone shows X ray evidence of destruction

3 Growths occurring in a tongue showing marked fibrosis and extensive chronic superficial glossitis Such changes are generally of syphilitic origin

Growths which do not fall in either of these categories may be treated by surgery or by irradiation with almost equal prospects of a five-year cure Patients who have undergone both irradiation and operation are not unanimous as to their preference and it is at least certain that a surgeon who is familiar with surgical technique and has no close acquaintance with the methods of application of radium acts in the best interests of his patients if he employs surgical methods

Palliation.—Recording palliative results is a very difficult matter and there is little published information on the subject Cade * referring to palliation by irradiation states that better palliation can be obtained by diathermy coagulation and that palliative irradiation is not worth doing as it does not prolong life and rarely increases the patient s comfort. This is not the opinion of all radiologists and there is no doubt at all that cases with very advanced incurable growths can be made very much more comfortable by irradiation which is admittedly palliative. Some part of the improvement no doubt is due to accessory methods employed for the alleviation of sepsis but my belief which is supported by the majority of radiologists is that large painful sloughing ulcers and fixed or ulcerating deposits in the neck which are quite clearly incurable may be greatly improved by irradiation

Incomplete operation is a disaster which no surgeon who has witnessed a diffuse recurrence in the neck will willingly risk and surgery with the knife has no place in the palliative treatment of carcinoma of the tongue

I propose in the following section to subdivide carcinoma of the tongue by a somewhat arbitrary classification which is partly clinical and partly pathological and to discuss separately the treatment of each class of case In considering this problem it must not be forgotten that the treatment of carcinoma of the tongue is inseparably

* Proc Roy Soc of Med 1947 XL, N 7

connected with that of malignant invasion of the glands of the neck. No treatment which neglects the glandular areas can be successful in anything but a very small proportion of cases whatever the stage or form of the disease. Having once realized this fact it is permissible to consider the *treatment of the primary growth first and that of the* glands later The alternative which is combined treatment either by operation or irradiation plays a larger part in the treatment of carcinoma of the tongue at the present day than it did ten years ago but it must be remembered that in many cases the primary growth and the glands are separated by normal tissue which forms a very useful barrier between the septic cavity of the mouth and the tissue planes of the neck. Past experience has shown that it is possible to leave this barrier intact treating the primary growth and the glands separately without running any great risk of recurrence in the barrier itself Methods which attack the primary growth and the glands together are now more often used in large centres but operations designed to do this carry considerably more danger than those which attack the tongue and the neck separately and operators who have no special experience in the surgery of the mouth and neck may be better advised to treat the primary growth by an intra buccal operation or by interstitial irradiation and to carry out a formal dissection of the glands of the neck as a separate operation.

(1) Localized growths confined to the mobile part of the tongue.— Growths of this type may be treated either by excision or by interstitial irradiation. Lesions on the dorsum are better adapted to irradiation and those on the tip or lateral margin to excision. There is little or no difference in the late results but interstitial irradiation properly per formed with suitable seeds or needles gives a better functional result and may leave the patient with a tongue practically indistinguishable from normal. It must be recognized that even after what appears to be a successful result from irradiation there may be loss of taste and other discomforts

Excision of localized growths on the anterior part of the tongue.— Sufficient exposure can usually be obtained through the mouth but if necessary access may be made easier by dividing the cheek in the manner already described (p 1887) The extent of the growth must be estimated by palpation as well as inspection and before commencing the excision traction stitches should be inserted at intervals round the growth and about three-quarters of an inch from its margin. Trotter has pointed out that if this precaution is neglected and the excision is performed while the *tongue is pulled out* by traction stitches in front of the growth the tissues posterior to it are stretched, and the margin of normal tissue behind the growth may be found on subsequent inspection to be inadequate

The excision should be carried out so as to leave an even margin of one-half to three-quarters of an inch of normal tissue in *all directions* Operations such as hemiglossectomy in which the incision follows

anatomical boundaries instead of being dictated by the extent of the growth are unsound as the lymphatics of the tongue anastomose very freely and the spread of carcinoma is not confined to any one direction

Bleeding is not difficult to control and the lingual artery which is the main source of anxiety can often be seen before it is divided lying close to the under surface of the tongue nearer to the frenum than to the lateral border If the operation is done with the knife or scissors there is a good prospect of primary union provided the raw surfaces are brought carefully together and the mucosa lightly sutured

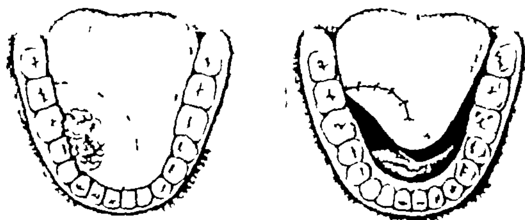


Fig 766 —Excision of localized growth in anterior part of tongue and repair of the resulting defect

Diathermy wounds much more often break down and may even result in secondary hæmorrhage If the gap left by the excision is too large to be closed by direct suture the tip of the tongue may be turned round and used to close the defect as shown in Fig 766

Whitehead's method.—This operation has been used with much success in the past and is suitable for growths which involve the greater part of the tongue without encroaching on the jaw or the floor of the mouth and for those in which local excision is *contra* indicated because of widespread precancerous changes in the rest of the tongue

Whitehead operated with the patient sitting in a rocking-chair under general anæsthesia which was allowed to become light in the later stages.* Under modern conditions it is better to use the recumbent position with the head propped well forward the pharynx being plugged and anæsthesia being maintained either by means of a nasal intratracheal tube or through a tracheotomy

The mouth is held widely open by an efficient gag and the tongue is drawn out by a traction stitch passed through its anterior part The whole operation is done with scissors The frenum is divided first and then the mucous membrane where it is reflected from the

* Whitehead, *Practitioner* May 1903, lxx, 583.

tongue to the jaw and later the attachment of the anterior pillars of the fauces is severed. This is a most important step in the operation and should be carried out at an early stage as it facilitates the later stages Bleeding is considerable but only spouting vessels need be picked up At this stage a large curved needle carrying a strong thread stitch may be inserted in the midline between the tongue and the symphysis menti and made to emerge just in front of the epiglottis. Traction on this stitch delivers the tongue even further and the epiglottis itself can be brought almost out of the mouth.

Removal of the tongue is now completed by dividing the genioglossi and the muscles of the base of the tongue from before backwards. The lingual arteries are very constant in position (*see* p 1808) and can usually be picked up with artery forceps before they are divided. Before completing removal of the tongue a thread stitch should be inserted through the glosso-epiglottidean folds This suture may be left in place for 24 hours after operation in case it becomes necessary to use it as a tractor for the control of reactionary hæmorrhage or post-operative respiratory obstruction In the original operation no attempt at closure of the mucous membrane was made If closure is thought desirable the gap in the anterior part of the floor of the mouth may be sutured in a straight line in the sagittal plane and, if it has been found possible to spare a sufficient amount of the mucosa in front of the epiglottis this can be brought forward to cover the muscular stump of the tongue so that complete closure is obtained with a T-shaped scar

Irradiation of localized growths.—Interstitial irradiation of localized growths can be carried out satisfactorily by any simple arrangement of needles which conforms in the amount and evenness of distribution with the principles stated on pp 1827–9 Radon seeds cause the patient less discomfort and because they interfere less with swallowing they are supposed to be followed less often by chest complications

A single-plane implant is adequate for small lesions in the mobile part of the tongue. If the implant is planned on the lines detailed on p 1827 a block of tissue the size of the plane and 1 cm thick will be treated, and this is sufficient for localized non infiltrating growths. Horizontal plane implants are suitable for the dorsum of the tongue and may be carried out with needles, but owing to the curvature of the tongue it is seldom possible to use needles more than 8 cm. long If a plane longer or wider than 8 cm. is required it is made up by short needles arranged end to end rather than by long needles. Horizontal single-plane needle implants are difficult to work out for lesions affecting one side of the tongue and extending towards the dorsum and under surface Vertical needle implants or single-plane seed implants are generally better

Teleradiation with the radium beam is useful in localized growths when it is desired to treat the primary growth and the glandular areas in continuity This necessity arises occasionally in small growths when they are of highly anaplastic type and have given rise to secondary deposits which are disproportionate to the extent of the primary

lesion In this case the glands are usually unsuitable for operation either because of their size or the rapidity of their growth and it is better policy to treat them and the primary lesion together by teleradiation The method is also sometimes used for old and feeble patients but it is doubtful if the upset occasioned is any less than it is with the interstitial method

(2) Localized growths developing in a tongue affected by chronic superficial glossitis.—Induration of the submucous tissue makes it difficult to be sure of the extent or even of the presence of a carcinoma in many cases For the same reason it is difficult to assess progress after irradiation and the surgeon may be long left in doubt as to whether the treatment has been successful or not. Moreover growths in tongues affected by chronic superficial glossitis react badly to irradiation and it is best to treat this class of case by operation If there is any special reason for avoiding operation interstitial irradiation is justifiable and may result in a cure.

Unless the whole tongue is removed primary union is difficult to obtain even after excision with the knife but the scars left by healing of unsutured diathermy wounds are generally soft and pliable and diathermy excision with a low current and no attempt at closure of the wound is a useful method Whitehead s operation may be used when the condition of the tongue is such that it is unwise to leave any part of it. An inlay graft may be used to close the defect in the mucosa if the excision has been done with a cutting instrument but not if diathermy has been used

(3) Growths of the anterior two-thirds of the tongue involving the floor of the mouth or the jaw —These growths are really a later stage of group (1) and like them may be treated by operation or irradiation provided that the treatment covers the whole of the affected tissue and an adequate margin beyond it The only absolute indications for operation are involvement of the compact bone of the lower jaw and persistence of growth in tissues which have already been fully irradiated Involvement of the mucosa covering the lower jaw may sometimes be cured by irradiation but only at the expense of damaging the bone to such an extent that the patient is not free from the risk of necrosis for many years after treatment Irradiation should not be used for any case showing bone involvement of a greater degree than this as it is most unlikely to cure and may increase the sufferings of the patient greatly by causing necrosis

Thus the decision in cases showing extensive bone involvement is not difficult Operation is the only chance of cure or of reasonable prolongation of life and its risks must be faced

At the other end of the scale are cases in which the growth is small and is limited to the superficial soft tissues in the floor of the mouth and there is no clinical evidence of spread to the lymph glands Such cases are very suitable for irradiation with or without a subsequent

gland dissection while operation (which must involve division of the jaw) is a measure of disproportionate severity

The most difficult cases are those in which the growth involves the floor of the mouth and shows evidence of direct spread to the tissues of the sub-maxillary triangle In such circumstances the only operation which is of any value is one which combines operation on the glands of the neck with that on the primary growth The operation previously carried a recorded mortality of between 40 per cent and 50 per cent * Mortality is much lower under modern conditions and operation is now the best treatment unless the patient is a very poor operative risk. The operation generally involves removal of the growth together with a portion of the lower jaw and the contents of the sub-maxillary triangle The nodes of the deep cervical chain should not be deliberately exposed at the primary operation but the jugulo-digastric gland should be removed for biopsy and if it proves to contain growth a radical clearance of the remaining glands of the neck should be done at a subsequent operation In cases in which operation is not feasible irradiation may be used and sometimes causes the ulcer to recede or even to disappear It involves a considerable risk of subsequent necrosis of the jaw and generally produces so much fibrosis *in the tissues of the sub-maxillary triangle that a subsequent* gland dissection is out of the question No fixed rules can be laid down but in most cases it is better to accept the risk and to advise an operation which gives the patient a chance of cure

If irradiation is chosen tele irradiation is the best method. Over irradiation must be avoided at all costs as it is certain to cause necrosis without curing the growth and so to increase the sufferings of the patient

Operations for growths of the tongue which involve the floor of the mouth or the jaw—The available methods of approach are detailed *on pp 1887–44 They are as follows* —

(1) Horizontal division of the cheek.
(2) Median division of the jaw
(3) *Kocher s lateral submandibular approach*
(4) Lateral division of the jaw by Langenbeck s method

(1) **Horizontal division of the cheek.**—This method which is by far the best for mobile growths at the side of the tongue can also be adapted to cases which show extensive bone involvement and is suitable for their removal when there is no demonstrable connection between the primary growth and the glandular metastases and no deep infiltration of the muscles of the base of the tongue. The first stage of the operation consists of a radical dissection of the glands of the neck, according to the technique described on p 2056 The external carotid artery is ligatured during the gland dissection. It is necessary to reverse the usual order and to do the gland operation first if this method is

* Morrow *Annals of Surgery* 1937 pp 105 418.

used as the mouth operation disturbs the contents of the submaxillary triangle too much to allow a satisfactory gland dissection at a later date

At the second operation which is undertaken as soon as healing of the neck wound is complete the cheek is split from the angle of the mouth to a finger s breadth in front of the posterior border of the masseter (p 1887) and the jaw which can be exposed by turning down the lower flap is divided in front of the growth By elevating the masseter and the parotid the ramus of the jaw is exposed and it is divided well behind the growth The posterior section can be carried as high as the neck of the jaw if necessary and the isolated segment of the mandible together with the affected part of the tongue and the tissues of the floor of the mouth connecting them is removed The internal wound is closed by bringing the remains of the tongue across to meet the mucosa of the cheek on the affected side and if necessary tension is relieved by deep sutures which are inserted through the tongue and passed so as to include the bed of the removed segment of the lower jaw in their grip before being tied externally over rubber tubing The wound in the cheek is repaired by the method described on p 1887 The operation necessarily leaves a considerable deformity but it is better not to attempt any reconstructive measures until healing has been complete for at least one year

(2) **Median division of the jaw—Syme s method** —This operation is most suitable for cases in which the growth has spread in the floor of the mouth without invading the compact bone of the lower jaw As it does not interfere greatly with swallowing and the tissue planes of the neck are not widely opened up to infection from the mouth the mortality is low If it is thought that the excision will have to be extended posteriorly on the lateral wall of the pharynx preliminary ligature of the external carotid is advisable in other circumstances it is unnecessary

The preliminary steps of the operation are described on p 1888 After division of the jaw in the midline its two halves are drawn apart by sharp hooks or strong thread sutures and the fatty submental tissue is removed and the mylohyoid divided in the middle line The mucous membrane to the outer side of the growth is divided from before backwards and as the halves of the jaw are still further separated the lingual nerve is seen together with the submaxillary duct and the deep portion of the submaxillary gland These structures lie close under the mucosa of the floor of the mouth and must generally be sacrificed the submaxilliary duct and the deep portion of the gland being separated from the rest of the gland at the posterior border of the mylohyoid. The hypoglossal nerve appears at a lower level on the outer surface of the hyoglossus running upwards and forwards into the substance of the tongue The trunk of the nerve and some of its posterior branches can usually be spared the lingual artery is exposed and ligatured as it emerges from under cover of the hyoglossus The tongue is now drawn forwards and the insertion of the

genio-glossus divided near the jaw The hyoglossus is then divided leaving the tongue attached posteriorly by the styloglossus and the faucial pillars The posterior margin of the growth is now examined and if there is no extension on to the palate or pharyngeal wall the faucial pillars are divided and the freed portion of the tongue is removed. If the growth extends farther back the mucous membrane on the outer side of the tonsil is divided so that the tonsil and part of the lateral wall of the pharynx can be displaced inwards with the tongue The soft palate is sometimes involved by an extension along the anterior pillar and if necessary a part of it may be removed. The operation is completed by dividing the lateral wall of the pharynx behind the growth.



Fig 767 —Late result, after ten years, of excision of the tongue by Syme's method. A radical gland dissection was also performed. The depression under the chin was caused by the extraction of a sequestrum from the midline of the jaw

Closure —If a defect is present in the lateral wall of the pharynx it is closed by direct suture The floor of the mouth can usually be closed by uniting the mucosa of the affected side of the floor of the mouth to the line of section in the tongue as the two halves of the jaw are allowed to fall together The submaxillary duct or if this cannot be identified the stump of the divided deep process of the gland must be implanted in this suture line. The divided jaw is united with silver wire or catgut and the external wound is closed from the lip to the point of the jaw The submandibular portion of the incision should not be closed completely If there is no gross sepsis in the mouth and union of the mucosa has been satisfactory the wound is partially closed round a drainage tube With marked sepsis or uncertainty regarding closure of the mucous membrane it is better to pack this part of the wound. This reduces the risk of serious septic complications and the wound heals rapidly after removal of the packing

Kocher used a modification of this operation in which he divided the jaw to one side of the mid line without freeing the soft parts from its posterior surface This brings the plane of separation directly to the outer side of the geniohyoid and the separation of the growth from its lateral attachments is achieved by drawing the tongue over to the sound side together with the corresponding half of the jaw

(8) **Lateral division of the jaw** —This is the best available method for cases in which it is necessary to remove a portion of the whole

thickness of the body of the jaw and for those in which the operator wishes to clear the submaxillary triangle at the same time as removing the primary growth

The method has been little used in the past 20 years because of the fear of pulmonary complications and post-operative sepsis These complications are so much less common in the conditions of the present day that I now use the lateral approach as a routine for extensive growths of the side of the tongue believing that the advantages of clearing the submaxillary triangle and obtaining a clear view of the base of the tongue at the level of the hyoid more than compensate for the increased severity of the operation It is a very useful method for cases which have already undergone irradiation as it permits a wide removal of the irradiated tissues which seem to have little resistance to the spread of growth if a recurrence appears

Having approached the growth by the method detailed on p 1841 it is generally convenient to bring the whole tongue into the wound a step which is made possible by removal of part of the body of the jaw when this is required or by simple division of the jaw in the line of the anterior molar tooth If the jaw is small and the alveolus is atrophic a sufficient exposure can be obtained by dividing the mucosa in the alveo-lingual sulcus posteriorly and continuing the incision forward to divide the mylo-hyoid and the genioglossus The tongue can then be displaced downwards into the wound below the intact jaw This exposure is not adequate if the growth extends back to the region of the anterior pillar and in any case closure is easier and more secure if the jaw is divided

With simple division of the jaw it may be necessary to divide the genioglossi close to the jaw before the tongue can be mobilized Once the tongue is displaced into the wound the extent of the growth is easily appreciated and the next step is to outline it by an incision with the diathermy knife a sufficient distance from the visible and palpable margin. The incision thus marked out includes a variable proportion of the tongue as far down as the epiglottis of the floor of the mouth and if the growth ends posteriorly above the tongue portions of the fauces and the lateral wall of the pharynx and of the palate may be included Laterally the outer boundary of the tissue to be excised may be in the floor of the mouth if the bone of the jaw is not involved but if there is extensive involvement of the bone of the jaw the lateral boundary can easily be extended up into the cheek

Growths which are sufficiently extensive to require this operation must be assumed to have infiltrated the muscles of the tongue down to the hyoid bone and the muscles of the affected side of the tongue must be divided at this level Thus the next step of the operation is to divide the muscles of the tongue below at the level of the hyoid bone and to work upwards from this level through the substance of the tongue to the line previously marked out by diathermy clear of the growth on the dorsum of the tongue This part of the operation must be conducted without regard to the amount of tongue removed

the sole consideration being to keep well clear of the growth Even when only a narrow tape like strip of tongue is left on the unaffected side there is seldom much difficulty in closure. Diathermy is a convenient means of division as its use is attended by less oozing from small vessels but the violent contractions of the tongue muscles which it provokes make it difficult to keep accurately to the proposed plane of division The posterior attachments in the region of the fauces and lateral wall of the pharynx are divided last. Fig 768 shows a tongue removed by this method. The figure emphasizes the necessity for removing the muscles of the tongue down to the hyoid as the infiltration of the growth in this direction is well shown. The patient was a man of 72 who had been treated previously by a local operation He survived three years and died of a pulmonary metastasis without local recurrence.



Fig. 768 —Tongue removed by lateral approach showing infiltration of muscle as far as the hyoid. Patient died 3 years later of pulmonary metastases without local recurrence.

Closure —Closure in these cases is not unduly difficult provided that it has been possible to spare a third of the dorsum of the tongue on the sound side If there is a defect in the lateral wall of the pharynx this should be directly sutured first The faucial arch is then reconstructed by suturing the remaining portion of the base of the tongue to the remaining tissues at the point where the upper and lower alveoli meet and closure is completed by suturing the remains of the tongue to the alveolar mucosa or to the mucosa of the cheek if the jaw has been removed. If the excision has been extended on to the cheek and the orifice of the parotid duct has been removed, the duct or the anterior process of the parotid must be implanted into the incision.

It is important to suture the sub-mucosal tissues accurately and I now pay more attention to this step than to the suture of the mucous membrane itself If the sub-mucous tissues and muscles are sutured in such a way that no dead space is left sepsis and fistula formation is rare even if the suture of the mucous membrane itself is not very accurate Closure is much easier if a considerable portion of the jaw has been removed when the skin flap is replaced it should be anchored to the underlying tissues by a few mattress sutures.

The wound may be completely closed if suture of the muscles and sub-mucous tissues appear satisfactory If this suture has been unsatisfactory it is better to close both ends of the skin wound and to

put a petroleum jelly pack in the centre If this is done leakage will lead to a temporary fistula but not to severe sepsis

Irradiation of extensive growths of the anterior third of the tongue — Irradiation of extensive growths of the tongue by deep X rays is less successful than other methods except when the growth is highly anaplastic. It is not generally used for squamous growths though Martin* states that a combination of fractionated peroral Rontgen irradiation supplemented by radon seeds is probably the most useful and practical method so far devised in the treatment of the primary lesion in cancer of the tongue He uses metal cylinders attached to the tube holder which allow the treatment to be administered through the mouth and daily treatments with single doses of 300–400 r have been reached Details of the subsequent interstitial irradiation by seeds are not given

Irradiation with radium and radon —Extensive lesions of the tongue are not susceptible of cure by surface application of radium and the available methods are therefore tele irradiation needle implantation and radon seed implantation

Tele-irradiation has so far not replaced interstitial methods completely and Paterson states that many cases treated by tele irradiation require subsequent implantation It is probably the best primary treatment in cases in which there is infiltration of the submaxillary triangle in continuity with the primary lesion In these cases subsequent implants may be necessary for residual areas of growth inside the mouth Tele-irradiation is also the best form of treatment for growths on the lateral border of the tongue which are very highly malignant and show evidence of early and extensive spread to the regional lymph glands and in such cases X rays should be used if a radium beam is not available.

A high grade of malignancy may be made evident in several ways A small primary growth which has already given rise to widespread metastases is always highly malignant and nearly always incurable. Most growths which infiltrate widely and give rise to little ulceration are of the anaplastic type. They are generally very radiosensitive but highly malignant. They can usually be made to disappear by tele-irradiation but they nearly always give rise to remote metastases within five years In these cases the patient gains little advantage in exchange for the danger and discomfort of interstitial irradiation and tele-irradiation is preferable The malignancy of a growth can also be estimated by examination of microscopic sections of a biopsy specimen Such estimates should be taken in conjunction with clinical findings as it is not certain that biopsy findings are constant throughout the mass of a large tumour and small biopsies taken from one portion of the tumour may be misleading

Tumours which have infiltrated the whole substance of the tongue and have spread to the regional lymph glands simply by virtue of the

* *Arch Surg.*, 1940, xl, No. 4, p. 912.

time which elapsed before the patient reported for treatment should also be regarded as incurable and treated by palliative tele-irradiation.

For implants needles have several advantages over seeds. It is easier to place them accurately and if by subsequent X ray check, the implant proves to be inaccurate the needles can be withdrawn and reinserted. On the other hand the presence of radium needles in the tongue for any length of time is very distressing to the patient the needles are liable to come loose and to protrude sufficiently through the tissues to cause a burn or else to drop out altogether

Seeds are more difficult to insert with accuracy and although it is in theory possible to insert them so that they are removable they are in fact generally left *in situ* permanently once they have been inserted. This precludes the possibility of altering the original distribution if on X ray check it is found to be inaccurate.

In patients who are old and particularly liable to pulmonary complications it is probably better to use seeds as they do not limit the movement of the tongue very greatly and consequently predispose less to pulmonary complications In younger patients who are not unduly liable to chest complications the advantages of needles probably outweigh their disadvantages

Technique —Whether seeds or needles be used there is a very great advantage in carrying out the insertion through a perspex jig which makes it certain that the needles or seeds are inserted at the correct angle (*see* p 1828) It is the business of the surgeon to acquaint the physicist with the volume and shape of the block of tissue which it is desired to irradiate remembering that irradiation should include all tissues which contain cancer cells but must not be extended too widely beyond the necessary limit as this interferes with the reaction of the tumour bed. If a jig is to be used it is the business of the physicist to construct this and to plan the insertion in such a way that the irradiation will be uniform and the dose adequate. In doing this however he must be in close consultation with the surgeon in order to ensure that the plan of introduction is a feasible one (i.e. that the mechanical difficulties of insertion are not such as to make it impossible for the surgeon to follow the physicist s plan)

Single plane implants are not adequate for the treatment of growths of the tongue which extend widely in the substance of the organ or have spread beyond its limits into the floor of the mouth or the fauces For such cases volume implants or some form of multi-plane implant must be used

The principles on which volume implants are calculated are described on p 1828 Such implants are suitable for lesions extending deeply into the substance of the tongue whether or not they invade the floor of the mouth, and the volume of tissue to be irradiated may be calculated without regard to the shape of the mucous surfaces For instance in an extensive growth involving the whole of the tongue and the floor of the mouth a volume implant may be planned to irradiate the whole of the tissue contained within the bony boundaries of

the lower jaw Nuttall* suggests that in such cases it may be found expedient to stitch the tongue to the floor of the mouth and states that the periphery of the volume may be entirely in the tongue or may extend anteriorly as far as the lower lip if alveolar extension renders it necessary Certain general principles must be observed in planning volume implants in this situation —(1) It is unwise to place needles outside the alveolous for fear of causing bone necrosis (2) Where the volume is large the tumour dose must be reduced correspondingly and if the whole tissue within the boundaries of the lower jaw is to be irradiated the dose should not exceed 5 500 r

Volume implants are best done with needles and generally it is better to design the implant in such a way that most of the needles are inserted externally through the skin of the submaxillary and submental regions and a lesser number through the mucous membrane of the mouth Implants of this sort can be made very accurate by the use of a perspex jig (*see* Fig 749) It is less easy to attain accuracy with the needles inserted through the mucosa of the mouth and in large growths it may be quite impossible to maintain the needles in position because of the friability of the tissues concerned

In some cases it is necessary to irradiate a block of tissue of a complicated and irregular shape and for this type of case a two-plane implant is most suitable. A good example of the type of growth which requires a two-plane implant is that which affects the tongue at the point where it is joined by the pillars of the fauces and also spread on to the lateral pharyngeal wall For this type of lesion the tongue pterygoid implantation was devised by R G Hutchison† (quoted by Nuttall‡) Nuttall gives the following description of the technique

Three 3 mg needles of 4 5 cm active length and 6 cm total length are introduced through the mucosa of the cheek and are passed backwards through the pterygoid region lateral to the pterygo-mandibular raphe and medial to the ramus of the mandible A fourth lowest 3 mg needle is usually found to deviate outwards and pass outside the jaw The anterior ends may be crossed vertically in the cheek with 2 mg needle of 3 cm. active length and 4 5 total length This constitutes the pterygoid plane.

The tongue plane consists of four 2 mg needles which enter the dorsum as far back as possible and pass down vertically or preferably with some lateral inclination They are about 1½ cm apart and are crossed by a single 1 33 mg needle of 2 cm active length and 3 5 cm. total length in the soft palate With the mouth closed the tongue may be regarded as being in contact with the palate.

Simpler two-plane implants may be used for other lesions extending deeply into the tongue provided they are not too large in size to be covered by two planes constructed by needles inserted vertically with a distance of about 2 cm between the planes

* *Brit Journ Radiol.*, 1943, XVI, No. 183
† *Proc Soc Radioth Gt Brit & Ireland* (see ref Nuttall, p. 1830 *footnote*).
‡ *Brit Journ. Radiol.*, 1943, XVI No. 183.

Growths which extend backwards to the pterygoid region may cause a great deal of trismus and on this account it may be very difficult to expose them well enough to ensure accurate placing of radium needles. In such cases greater accuracy can be attained by increasing the exposure by slitting the cheek (*see* p 1887)

Growths of the posterior third of the tongue—Most of these growths are anaplastic and many of them belong to the infiltrating non ulcerating type. No growth suspected of belonging to this group should be submitted to operation other than biopsy as any form of mass-irradiation will ensure disappearance of both primary growth and metastases A preliminary biopsy should be done and if the growth proves to be anaplastic distant irradiation with the radium beam is the most efficient means of attack but deep X ray therapy is very nearly as good In the absence of either of these both primary growth and glands should be treated by interstitial irradiation

Unfortunately most of these tumours recur in parts of the body remote from the primary lesion so the five year survival rate is very low The site of the primary growth and that of the immediate metastases often remain free from recurrence until the end and at the time when these patients die it may be impossible to say from clinical examination where the primary lesion lay

Squamous carcinomata occur in the posterior third of the tongue although they are rarer than undifferentiated growths They are generally recognizable clinically by earlier ulceration and the hardness and fixity of the metastases. For them the general rule holds good that if the primary growth and the metastases are not obviously connected their treatment should be considered separately Interstitial irradiation for the primary growth and dissection of the affected glands is the best treatment The glands of both deep cervical chains are generally affected.

Preliminary tracheotomy should be carefully considered before the irradiation is carried out remembering that insertion of needles in the posterior third of the tongue may produce œdema round the upper opening of the larynx either immediately or after the lapse of several days

Technique of interstitial irradiation of growths in the posterior third of the tongue.—An estimate of the shape and volume of the tissues to be irradiated must be made with one finger in the mouth and the other in the hyoid region without drawing the tongue out of the mouth A volume implant is generally necessary It is extremely difficult to insert needles accurately into the base of the tongue through the mouth as the area can be exposed only by drawing the tongue out to some extent and needles which are inserted with the tongue drawn out of the mouth become bunched together when the tongue is allowed to resume its normal position. Greater accuracy can be obtained by inserting the needles through the skin of the neck in the suprahyoid region The hinge type of perspex jig is a great help in attaining accuracy in this region. The disadvantage

to inserting needles through the skin of the neck is that it inevitably produces some degree of fibrosis which interferes with the subsequent gland dissection and as far as possible the needles should be arranged to enter the substance of the tongue in the hyoid region without passing through the tissues of the submaxillary triangle

Many growths of the posterior third affect the glands on both sides of the neck and if there is doubt of the patient s ability to stand a bilateral dissection or if the glands are so advanced as to put in question the possibility of a radical removal teleradiation should be used in place of the interstitial method and the glands included in the treated area

Operation.—The value of operation is more questionable in the posterior third of the tongue than anywhere else in the mouth It has already been stated that anaplastic growths are totally unsuited to operative methods Of the squamous growths there is a small group which are accessible by Trotter s method of median division of the jaw and tongue. For growths which are limited to the centre of the base of the tongue in the epiglottic region this method gives an excellent exposure and allows excision with an adequate margin without risk of severe sepsis The preliminary steps of the operation are described on p 1814 When the median incision comes within range of the growth excision is begun by cutting outwards on either side As soon as the growth has been separated from the tongue it can be drawn upwards into the wound the ary-epiglottic folds divided and a horizontal cut made across the epiglottis just above the vocal cords. The growth is now free from everything but the body of the hyoid bone and all that remains is to disarticulate the latter from the great cornu on each side Neither of the lingual arteries is as a rule seen or divided The large gap left by removal of the growth is closed by sutures which draw the parts together in the midline This manœuvre is rendered easier by the absence of the body of the hyoid bone The two halves of the tongue are then stitched along the dorsal and ventral surfaces and after uniting the separated halves of the jaw the lip is repaired and drainage established in the sub-mental region. (Trotter)

This operation is unlikely to be followed by severe septic complications and does not interfere with a subsequent gland dissection Even in cases which are unlikely from the presence of metastases to provide a permanent success the operation is justifiable as it is capable of giving a good palliative result without undue risk Localized growths confined to the posterior third can also be removed by a lateral approach with division of the jaw The posterior part of the tongue is removed together with the contents of the submaxillary triangle on the side from which the approach is made Closure is effected by displacing the anterior part of the tongue downwards and backwards and suturing it to the hyoid The deformity is remarkably slight

Choice of treatment in carcinoma of the pharynx—Wilfred Trotter* made the following statement There are two methods of treating cancer of the pharynx radiotherapy and operative excision It is not perhaps a wholly unjustified paradox to say that at the present moment the existence of the two methods tends rather to halve the chances of the average patient than to double them. It is not to be *expected that people will be equally masters of both methods so that* vaguely conceived and indecisive efforts are apt to be made and useless combinations of the two procedures depended on.

The difficulties of selecting appropriate treatment for carcinoma of the pharynx are very great because the disease is very fatal and prolonged survival of cases treated by any method is uncommon. Trotter† demonstrated the possibility of prolonged survival after surgical treatment when in 1932 he published details of eight cases with an average freedom from recurrence of over eight years the longest being twenty years and the shortest three and a half Six of the eight had survived seven years or longer These cases included growths of the lateral wall of the pharynx of the pyriform fossa and of the post cricoid region In Trotter's day the operation of pharyngotomy for carcinoma was a formidable undertaking and the mortality and morbidity were very high. A period followed in which surgery was largely replaced by radiotherapy but it is now becoming obvious that the results of irradiation are no better than those of surgery and it seems likely that in the pharynx as elsewhere in the upper alimentary and respiratory tracts there is no justification for adoption of either method to the exclusion of the other

Berven‡ gives the result of treatment of 104 cases of carcinoma of the pharynx treated from 1929 onwards Of these 64 per cent were women and therefore presumably post-cricoid carcinomata Forty five were treated by X rays 34 with X rays and teleradium and 25 with teleradium. A two-year cure was obtained in 12 per cent There is one five-year survivor of the 104 patients treated Baclesse§ records 6 per cent of five-year cures in a series of 425 cases of carcinoma of the pharynx treated by irradiation and draws attention to the frequent occurrence of secondary growths among those patients who were apparently cured of the original growth and discusses the possibility that the secondary growths are provoked by the irradiation used in treatment of the original cancer The Holt Radium Institute at Manchester reported in 1945 on a series of 220 cases with a five-year survival rate of just over 4 per cent In their experience the most effective technique is that described as the collar and bougie technique which is applicable only to people of a certain physical configuration. It is said to be unsuitable for patients in whom the regional lymphatic glands are involved As it involves retaining a

* T Rowland Hill, *Treatment of Some Common Diseases* Malignant Disease of the Pharynx. Edinburgh Livingstone.
† *Brit. Med. Journ.*, 1932, 510
‡ *Acta Radiol* 1937 xviii, 29
§ *Journ. Amer Med. Assoc* 1949, cxl, No 6

bougie passed through the growth for a period of two hours at a time it places a very severe strain on the endurance of the patient and is by no means free from risk to life

Better results are quoted for series of cases which include growths confined to the larynx but these are deceptive as many of the laryngeal growths are benign and easily treatable For true pharyngeal carcinoma no results significantly better than those above have been published and it is a fair conclusion that it has so far proved possible to cure only an occasional case of carcinoma of the pharynx by operation or irradiation Better results may come from technical improvements in either method by a combination of them both or by a better selection of cases suitable for treatment by one or other method

The choice between operation and irradiation in pharyngeal growths is subject to the general considerations mentioned on p 1822 with certain limitations imposed by the anatomical situation of the growth Thus lymphomata and other growths of an anaplastic type should not be subjected to operation and growths in which the regional lymph nodes are invaded and cannot be clearly separated from the primary growth are also unsuitable for operation The latter group includes a large proportion of advanced pharyngeal growths in which a mass in the position of the tonsillar gland lies directly over the pharyngeal ulcer Growths which fall into either of these categories should be treated by tele-irradiation In the lymphomata the primary lesion can generally be made to disappear but remote recurrence is the rule In the group in which there is continuity between the primary growth and involved lymph nodes some palliation may be obtained but cure is very unlikely indeed

In considering the choice between operation and irradiation for pharyngeal growths which do not fall into these two groups certain special considerations must be taken into account. With the exception of growths on the lateral pharyngeal wall all growths in the hypopharynx are in close relation to cartilage In particular growths of the post-cricoid group are certain to come very close to the cricoid cartilage at a very early stage in their progress and are consequently particularly unfavourable for radiotherapy The second factor which must be taken into consideration is that all pharyngeal growths including those of the lateral pharyngeal wall are so inaccessible and so complicated in shape that interstitial irradiation can be carried out with accuracy only after a preliminary operation for exposure of the growth Combinations of major surgical methods of exposure with interstitial irradiation have met with little success and are seldom used The choice therefore lies between tele irradiation and operation

The possibilities of operation are dependent to some extent upon the situation of the tumour Thus growths which originate on the lateral wall of the pharynx are often particularly favourable partly because the relatively wide pharynx above the cricoid allows the growth to fungate and give rise to symptoms and physical signs before it is very far advanced and partly because there is in this situation a better

opportunity of excising the growth with an adequate margin and obtaining early and satisfactory closure. These growths often appear more extensive on laryngoscopy than they really are as the fungating part of the growth may be much larger than the base from which it originates.

Growths originating in the pyriform fossa or on the ary-epiglottic fold are much less satisfactory from the surgeon s point of view though here again it is possible for a growth to fungate and give the appearance of a large mass while its base is still localized. Post-cricoid growths have no space into which they can fungate and are nearly always flat ulcers with a disproportionate amount of infiltration A small proportion of early pyriform fossa and post-cricoid growths can be removed by transthyroid lateral pharyngotomy without removing the larynx. A very much larger proportion is operable if the operator is prepared to go on to a laryngo-pharyngectomy leaving the patient with a permanent tracheotomy I believe that this procedure is justifiable in many cases in view of the poor results of radiotherapy and of the advances which have been made in speech therapy and I have no *hesitation in advising laryngo-pharyngectomy to a patient suffering* from carcinoma of the pharynx who is sufficiently active-minded to learn to speak with an oesophageal voice

Technique of irradiation for carcinoma of the pharynx.—No detailed description will be given as interstitial methods are seldom used and both tele-irradiation and the collar and bougie method applied to carcinoma of the pharynx require all the resources of a large radiotherapy department.

Technique of operation for carcinoma of the pharynx.—*Technical steps in the removal of growth from the pharynx after exposure by lateral pharyngotomy*—The steps of the preliminary exposure are detailed on p 1848 The removal of the greater cornu of the hyoid bone is an essential step as it gives a much better exposure and makes ultimate closure much easier and more satisfactory

After the cornu of the hyoid and the greater part of the ala of the thyroid have been removed the lateral wall of the pharynx from the epiglottis down to the lower border of the cricoid cartilage is accessible to palpation. If the growth is localized to the lateral pharyngeal wall it can be excised by making an incision with the diathermy knife in a line one-third of an inch outside the palpable limits of the growth. *This leaves a defect in the lateral wall of the pharynx* which can be partially closed by suturing but in accordance with Trotter s later practice it is better not to attempt complete closure and to approximate the posterior edge of the defect to the skin flap leaving a fistula above the level of the cricoid for closure at a later date.

The extent of post-cricoid or pyriform fossa growths can seldom be appreciated by palpation and in these cases the next step after exposing the lateral wall of the pharynx is to incise the pharyngeal wall at some point where the absence of induration makes it clear that

the incision is not going through the base of the growth and to use this incision in order to determine by inspection the extent of the growth to be excised After careful inspection of the growth a decision is made as to whether it will be necessary to remove the larynx or not In a few post-cricoid growths it will be found that the ulcer has not extended round the whole circumference of the pharynx and is not firmly attached to the cricoid cartilage In such cases it may be possible to excise the growth without removing the larynx Starting below at the front where the œsophagus has been freed and isolated (*see* p 1818) the posterior wall of the œsophagus and pharynx is freed by blunt dissection from the pretracheal muscles This part of the operation is usually simple The larynx and pharynx can then be rotated and by very gentle dissection an attempt is made to free the growth from the posterior surface of the cricoid If this is successful the next step is to decide whether it is possible to spare any part of the circumference of the post-cricoid œsophagus at the level of the growth This is rarely so and generally the next step is to divide the œsophagus transversely well below the growth and to complete the removal by dividing the œsophageal mucosa transversely just below the level of the arytenoids and carrying this incision round the posterior wall of the pharynx and above the upper limit of the growth In such a case a complete new epithelial lined pharynx must be constructed behind the larynx Fig 769 shows a case in which this has been done by wrapping the anterior skin flap round the larynx and uniting its edge behind the larynx to the edge of a flap taken from the infra clavicular region and turned in across the front of the prevertebral muscles This leaves a deep skin lined cleft behind the larynx continuous below with the œsophagus and above with the pharynx

Pyriform fossa growths are best exposed by a transverse incision in the bed of the hyoid bone and then dealt with according to their extent. If they have not passed across the midline it may be possible to perform a localized excision leaving a double fistula leading anteriorly into the larynx and posteriorly into the post-cricoid œsophagus with the lamina of the cricoid cartilage and the remaining arytenoid standing up as a barrier between the fistulæ

If in the case of a post-cricoid or pyriform fossa growth it is clear that an attempt to save the larynx will result in an insufficient margin of tissue being removed the larynx must be sacrificed. If the œsophagus has not already been isolated below the thyroid cartilage it must be separated from the trachea and held away by a tape The next step is to divide the trachea about the level of its second ring and to bring the lower end out through an incision in the skin immediately above the sternal notch securing it in position there by one or two catgut stitches. If possible the opening should be established just to one side of the midline so that the pharyngeal secretion does not run into the trachea in the post-operative period before the pharyngeal fistula is closed. The administration of the anæsthetic is continued through the distal trachea. It is wise to use a tube with an inflatable cuff to

prevent blood from running down the trachea. The anæsthetist should be warned of the short distance which lies between the opening and bifurcation of the trachea in case he inserts the tube too far and obstructs one bronchus

Before proceeding with the operation the œsophagus should be gently freed in the upper opening of the thorax by finger pressure to allow it to be brought well up into the wound. The operation is then



Fig. 769.

A, Conservative resection of post-cricoid carcinoma The larynx is intact and a skin lined cleft behind it has been produced by wrapping the anterior flap round the larynx and turning in a flap from the infra-clavicular region The cleft has been packed with cotton wool to show its extent. Above, it opens into the pharynx and, below it is continuous with the œsophagus, into which tube has been passed B, The photograph shows the condition after pharyngo-laryngectomy in a case in which it was possible to preserve strip of mucosa between the pharynx above and the œsophagus below The tracheotomy opening which is not shown lies to the left of the midline

completed by excising the growth under direct vision. It is very desirable to preserve a strip of mucosa to maintain continuity between the pharynx above and the œsophagus below as this makes subsequent reconstruction much easier It is often possible to do so in pyriform fossa growths even when they are very extensive but post cricoid growths which necessitate removal of the larynx generally involve the whole circumference of the œsophagus. It may be possible even in large post-cricoid growths to preserve a narrow strip of mucosa on the side of the pharynx opposite to the growth

The operation is concluded by turning in the flaps to meet the edges of the defect in the pharynx and passing a Ryle s tube down the œsophagus into the stomach No attempt is made to close the fistula completely at the original operation

Fig 769B shows a case some weeks after excision of a very extensive

growth involving the upper opening of the larynx with gross involvement of glands The intact strip of mucosa represents the left and posterior part of the pharynx and will form the basis of a new pharynx The right sternomastoid has been removed with the infiltrated glands The tracheotomy opening (which is not shown) is to the left of the midline

Post-operative Complications of Operations on the Mouth and Pharynx

Immediate shock —This complication was at one time very frequent after extensive operations in the mouth and neck but under present conditions with modern methods of anaesthesia it is seldom seen Properly conducted operations in this region do not lead to a great loss of blood but arrangements for blood transfusion should be made before operation in case the loss is unexpectedly large In prolonged operations a slow blood transfusion is often helpful in maintaining the general condition even if the actual loss of blood is not large

The two factors which contribute most to avoiding shock are gentleness in operative manipulation and even anæsthesia without respiratory obstruction Assuming that these necessities are provided for the duration of the operation is of little importance from the point of view of shock though it has an influence on the possibility of subsequent pulmonary complications

Operative shock occurs less frequently and is less serious in patients who are brought to the operating table adequately nourished and mentally at rest For this reason patients who are to undergo a major operation in the mouth must be given a sufficient period of preoperative treatment on the lines suggested on p 1892 and should on no account be operated upon directly they are taken into hospital

Sepsis —Sepsis is a cause for anxiety in all operations on the mouth and when it is necessary to open up the planes of the neck to infection from the mouth it may be sufficiently serious to cause death By proper use of antibiotics and sulphonamides the risks of sepsis are much diminished and it is now rare to see a fatality from sepsis alone Treatment with penicillin and streptomycin should be instituted the day before the operation At the time of the operation the risks of sepsis can be minimized by careful attention to operative technique with a view to reducing the chances of infection of the neck from the mouth cavity At the conclusion of operation the mucosa of the mouth should be carefully closed and supported by drawing the muscles together beneath it with interrupted catgut sutures The skin should never be tightly sutured in cases in which there is a great risk of the development of sepsis and in operations on the lateral portion of the tongue through the submaxillary triangle which carry a great danger of sepsis it is better to leave the middle of the skin wound unsutured and to pack it with petroleum jelly gauze The pack is removed on the third or fourth day Fistula formation is fairly common if th

method is used but the fistulæ usually close spontaneously and a temporary fistula is greatly preferable to severe spreading sepsis

Bulky dressings soon become sodden with decomposing discharges and external wounds should be covered lightly with gauze which can be changed frequently The suture line in the mucous membrane is often inaccessible and obscured by œdema. It is best treated by frequent syringing which the patient can soon be taught to do for himself by holding the head forward over a basin while he directs the stream of lotion over the wound from a Higginson s syringe. Until he is able to do this the mouth should be mopped out with solution of sodium bicarbonate and glycerine or boric acid

Pulmonary complications—In spite of improved anæsthetics antibiotics and chemotherapy chest complications are still formidable. Before operation every effort must be made to clear up sepsis in the mouth and at operation it is most important to prevent an unconscious patient from inhaling the discharges from the mouth After operation he must be nursed in a warm moist atmosphere and in some surroundings and at some times of the year a steam kettle is very helpful

These precautions are particularly necessary if a temporary tracheotomy has been done Over-sedation may leave the patient unable or unwilling to cough as much as is necessary to get rid of the discharges in the bronchi and it is important to ensure for at least a portion of the day that the patient is fully conscious and able to cough. An expectorant helps in this direction

Feeding—Patients must be properly fed in the post-operative period Many of them are old and have little reserve of strength and, if every feed is an ordeal to be dreaded intake very soon becomes limited and the patient loses strength and heart. Most patients tolerate a nasal Ryle s tube comparatively easily and this constitutes an easy method of administering sufficient fluid nourishment. After a few days most patients are able to swallow fluids which are delivered to the back of the pharynx by means of a rubber tube attached to a feeding cup

The greatest difficulties arise with patients in whom the whole tongue or a major portion of the posterior third has been removed and with those in whom it has been necessary to use the remaining portion of the tongue to reconstitute the floor of the mouth. Such patients find it very difficult at first to prevent the entrance of fluid into the larynx and attempts at swallowing may be followed by very distressing fits of coughing In these circumstances food must be administered by a Ryle s tube or if the patient cannot tolerate this by a gastrostomy The difficulties of swallowing can nearly always be overcome with the aid of skilled and patient nursing but the period which is required to overcome the difficulty depends not only on the nursing skill available but also on the intelligence and the degree of co-operation which the patient shows. The difficulties are much more formidable in patients who are old and slow of understanding

Special after-care in patients undergoing interstitial irradiation (*see also* p 1830) —Patients recovering from an anæsthetic after insertion of radium needles must be watched constantly as there is a natural tendency for a semi-conscious patient to drag foreign bodies out of his mouth and a patient returning to consciousness may pull out some or all of the needles Once the patient is conscious the routine treatment is much the same as in operative cases Gross œdema is an occasional complication in the first 12 or 24 hours and arrangements must be made for performing tracheotomy if necessary When the œdema is beginning to subside soreness and salivation may increase as a result of development of the radium reaction and towards the end of the week before the needles are removed the patient is often very uncomfortable indeed

As soon as the patient is able to leave his bed the position of the radium needles must be checked by X ray and in some centres it is the custom to make a reconstruction by means of X ray films If the implant proves to have been grossly inaccurate it is probably better to remove it altogether and to make an attempt at a more accurate distribution at a later date The individual needle punctures must be watched carefully and needles which tend to protrude must be reintroduced and if possible buried in the tissues as the projecting needle eye is likely to give rise to a burn in the tissues immediately surrounding it

Extraction of radium needles is generally easy but there are occasional difficulties when needles have been inserted through a tough fascia such as that in the submaxillary triangle In most cases a gentle pull on the thread is sufficient to dislodge the needle. If it is not it is better to avoid violent pulling on the thread and instead to pass a forceps along it and grasp the eye of the needle directly

THE TREATMENT OF LOCAL RECURRENCES

(1) **After irradiation.**—Distinction must be made between recurrences in the centre of the treated area and at its periphery A recurrence of growth in the centre of tissue which has been adequately irradiated means that there is too little difference between the sensitivity of the growth and that of its surroundings and that further irradiation is more likely to cause necrosis of the normal tissues than regression of the growth Thus recurrences of this type may be treated by excision or diathermy but never by irradiation Recurrences at the periphery of a treated area when the centre remains healed suggest that the original irradiation was too circumscribed and that a portion of the extending edge has been missed Such recurrences may be treated by irradiation provided that the surrounding tissues do not show scarring or telangiectases or other signs of over irradiation

(2) **After operation.**—Recurrences in the mouth after operative removal of carcinomata are often difficult to deal with by excision.

The amount of normal tissue which can be removed with the recurrence is strictly limited and owing to the induration of the scar tissue it is often very difficult to be sure how wide an excision is desirable Post operative recurrences in the mouth may therefore be better dealt with by irradiation on the principles which have been described for primary growths though the technical difficulties of securing adequate irradiation in tissues which are œdematous as a result of operation are great and the chances of cure are slight In the neck where the operator is less restricted in the amount of normal tissue which he can excise irradiation presents no advantages over operation unless essential structures which cannot be removed are involved

Treatment of Glandular Areas

It has already been indicated that in some cases it is impossible to regard the treatment of the glandular areas as a separate problem because there is evidence of direct connection between the primary growth and the metastases. Where no such evidence exists the treatment of the glandular areas is to be regarded as a separate problem.

It is now generally agreed that it is desirable to treat the primary growth first because there is no object in treating the glands if the primary lesion cannot be controlled and also because there is a danger that if the normal lymphatic fields are removed before the primary growth is controlled growth will be diverted into other lymphatic fields. The treatment of glandular areas should therefore be considered as soon as the primary lesion is healed or well on the way to healing

The most satisfactory treatment for cervical metastases is block dissection of the neck There are certain contra indications to this operation They are as follows (1) The presence of an uncontrolled primary lesion (2) fixity of the cervical metastases indicating spread of growth beyond the capsule of the involved glands (3) presence of distant metastases (4) evidence that the primary lesion was a lymphoma or other highly undifferentiated growth

In addition to these absolute contra indications there are also relative contra indications These are (1) *Poor general* condition and advanced age (2) presence of clinically involved lymph nodes in the posterior triangle (3) presence of bilateral metastases or obvious spread of the primary growth across the midline.

In my opinion these relative contra indications should not often be accepted. It must be remembered that one of the objects of gland dissection is to save the patient the pain and misery associated with advanced secondary deposits in the neck and this object should be pursued even at the expense of the discomfort and risk associated with a bilateral gland dissection in an elderly patient The fact that a patient is unlikely to survive five years is no excuse for allowing him to die of a painful and distressing condition and removal of cervical metastases should often be regarded as an object in itself independent of the prospects of prolonged survival.

There is therefore no question that a patient whose primary lesion has been controlled and who shows clinical evidence of metastatic deposits in the glands of the neck which are still operable should be submitted to gland dissection and in my opinion this decision should not be influenced by the presence of deposits on both sides of the neck or by the age and general condition of the patient When the primary lesion has been shown to be undifferentiated gland dissection should not be done as the immediate and ultimate results are at least as good with radiotherapy Tele irradiation is the best method but external applications with radium collars have also been used with success Interstitial irradiation should not be used

Cervical metastases which are inoperable because of extension of growth beyond the limits of the capsule of the glands may be treated by irradiation to delay the progress of the growth but they are not curable If the deposits are ulcerated tele irradiation is preferable

The most difficult group of cases is formed by patients in whom the cervical nodes show no clinical evidence of involvement. Palpability of the glands is a most unreliable indication as palpable glands particularly in the submaxillary triangle may result from sepsis and impalpable glands may contain early metastases Thus a decision must be reached taking into account the size and consistency of the glands but also giving due regard to the situation of the primary growth its size and duration the age and general condition of the patient and the possibility of keeping him under regular observation The most useful indication is furnished by the site of the primary growth For example less than 20 per cent of patients cured of carcinoma of the lip develop metastases in the glands of the neck and if the arrangements for follow up are reasonably adequate it is very doubtful whether anything is to be gained by submitting these people to a radical gland dissection when there is no clinical evidence of glandular involvement Most surgeons are satisfied to keep such patients under observation

In carcinoma of the tongue the position is exactly opposite as the incidence of cervical metastases is in the region of 80 per cent and the chances of a patient s escaping without the development of metastases after the cure of an early and localized primary lesion are small In my opinion the lymphatic areas should be cleared in all cases of carcinoma of the tongue in which the primary lesion has been controlled and the clearance should be bilateral if the situation of the primary growth suggests that bilateral invasion is likely

It is fair to state that clearance of the lymphatic fields even in these circumstances is no guarantee against the subsequent development of metastases If the primary growth is highly malignant there may well be widespread deposits both within and between the glands of the neck even when no palpable abnormality is present and dissection of the neck in cases showing no evidence of metastases is sometimes followed by recurrence

The position regarding growths in other situations is less well defined

Growths in the floor of the mouth in spite of their proximity to the submaxillary lymph glands show less tendency to invade glands than do those in the tongue Superficial growths on the alveoli and the uncommon type of carcinoma of the lower jaw which invades the compact bone with little superficial ulceration are also slow to invade glands Carcinoma of the cheek is more prone to invade the glands though still less so than carcinoma of the tongue In these doubtful cases the size and duration of the primary growth must be taken into consideration When a large primary growth has been controlled it is better to assume that the glands have been invaded but size must be taken into consideration in conjunction with rapidity of growth as a relatively small primary which has appeared and extended within a short period probably has a greater tendency to spread to glands than a larger primary growth which has appeared and spread very slowly

The above views regarding gland dissection are not universally held. Douglas* states that in dealing with infiltrating growths with no palpable glands he came to the conclusion after an exhaustive investigation that he was performing a block dissection unnecessarily in four out of five cases and that in the cases submitted to block dissection the results were little if any better than those obtained by waiting for the glands to appear He therefore advises a watch technique for such cases and states that 60 per cent of cancer clinics throughout the world have adopted this technique He emphasizes that such a technique is dangerous unless an intensive follow up system is in existence At some clinics routine irradiation of the lymphatic fields is practised in cases showing no clinical evidence of glandular metastases At the Norwegian Radium Hospital the practice is to include the glandular area in the field of irradiation designed for the primary tumour when glands are not palpable Gland dissection is not done in these cases and is reserved for those with metastases which are palpable but limited to one side of the neck and showing no evidence of infiltration of the capsule The value of these methods is very difficult to assess but they have not been generally adopted.

Technique of gland dissection for carcinoma of the mouth and pharynx.—The technical steps of the operation are described on p 2056 Two types of operation only are justifiable They are —

(1) Bilateral suprahyoid block dissection This operation is suitable only for cases of carcinoma of the lower lip and consists in dissection of both submaxillary triangles and the sublingual region the dissection being limited posteriorly on both sides by the posterior belly of the digastric muscle The glands of the deep cervical chain are not interfered with and can be removed later at a separate operation if required. This operation has advantages in patients with lesions of the lower lip which have involved the submental glands or are in a position to involve the submaxillary glands on both sides but it should not be used for any other form of carcinoma of the mouth.

* *Proc. Roy. Soc. of Med.*, 1947 xl, No. 7 418.

(2) The second type of operation is the radical block dissection which includes the sternomastoid and in unilateral cases the internal jugular vein. It is possible to remove both internal jugular veins provided an interval is allowed between the operations but it involves a considerable extra risk.

Although the operation of block dissection is a long one it is not dangerous under modern conditions. Douglas gives the mortality as 3 per cent.

Recurrences after gland dissection of the neck. Diffuse recurrences are seen occasionally. They result from errors of judgment in selection of cases and mean that a gland dissection has been undertaken in an unsuitable case. This error is sometimes unavoidable as a rapidly progressing growth may produce implantation secondaries in the tissues of the wound even though the original glands appeared to be easily operable. Diffuse recurrence leads to early death and treatment can be symptomatic only.

Localized recurrences are generally better excised if this is a technical possibility. It is important to be sure before undertaking excision of a recurrence that it is in fact a recurrence in the glandular area and not a direct outward spread from the tissues of the pharynx or base of the tongue. A considerable proportion of recurrent masses in the neck in the region of the angle of the jaw are really outward extensions from the primary growth. It is impossible to cure them either by operation or irradiation but while irradiation can be relied upon to delay their progress operation is directly harmful because the excision cannot be extended to include the origin of the growth in the mouth or pharynx and any removal which is done is necessarily incomplete.

Prognosis of Carcinoma of the Mouth and Tongue

The outlook in these cases depends on the type of growth and the tendency to metastases as well as the stage of advancement at the time when the patient first seeks advice. The most reliable indication is the site and by considering this in conjunction with the clinical characteristics and the presence or absence of obviously infiltrated glands a reasonably accurate estimate can be made of the chances of cure. A short history is by no means always a favourable point in the prognosis as patients suffering from rapidly growing and highly malignant lesions come for treatment earlier than those with more chronic types of growth. Lesions which are infiltrating and non ulcerating can generally be kept in check for years by irradiation but they nearly always lead ultimately to death. An ulcerating growth which is mobile has a better prognosis than a similar one in which widespread induration is present in the surrounding tissues.

Estimation of prognosis by the microscopic structure of the primary growth is helpful up to a point for the surgeon knows that nearly all highly anaplastic growths have metastasized to the glands by the time the patient comes for treatment whereas if the growth is well

Growths in the floor of the mouth in spite of their proximity to the submaxillary lymph glands show less tendency to invade glands than do those in the tongue. Superficial growths on the alveoli and the uncommon type of carcinoma of the lower jaw which invades the compact bone with little superficial ulceration are also slow to invade glands Carcinoma of the cheek is more prone to invade the glands though still less so than carcinoma of the tongue In these doubtful cases the size and duration of the primary growth must be taken into consideration. When a large primary growth has been controlled it is better to assume that the glands have been invaded but size must be taken into consideration in conjunction with rapidity of growth as a relatively small primary which has appeared and extended within a short period probably has a greater tendency to spread to glands than a larger primary growth which has appeared and spread very slowly

The above views regarding gland dissection are not universally held. Douglas* states that in dealing with infiltrating growths with no palpable glands he came to the conclusion after an exhaustive investigation that he was performing a block dissection unnecessarily in four out of five cases and that in the cases submitted to block dissection the results were little if any better than those obtained by waiting for the glands to appear He therefore advises a watch technique for such cases and states that 60 per cent of cancer clinics throughout the world have adopted this technique He emphasizes that such a technique is dangerous unless an intensive follow up system is in existence. At some clinics routine irradiation of the lymphatic fields is practised in cases showing no clinical evidence of glandular metastases At the Norwegian Radium Hospital the practice is to include the glandular area in the field of irradiation designed for the primary tumour when glands are not palpable. Gland dissection is not done in these cases and is reserved for those with metastases which are palpable but limited to one side of the neck and showing no evidence of infiltration of the capsule The value of these methods is very difficult to assess but they have not been generally adopted.

Technique of gland dissection for carcinoma of the mouth and pharynx.—The technical steps of the operation are described on p 2056 Two types of operation only are justifiable They are —

(1) Bilateral suprahyoid block dissection This operation is suitable only for cases of carcinoma of the lower lip and consists in dissection of both submaxillary triangles and the sublingual region, the dissection being limited posteriorly on both sides by the posterior belly of the digastric muscle The glands of the deep cervical chain are not interfered with and can be removed later at a separate operation if required This operation has advantages in patients with lesions of the lower lip which have involved the submental glands or are in a position to involve the submaxillary glands on both sides but it should not be used for any other form of carcinoma of the mouth

* Proc. Roy. Soc. of Med 1947 xl, No. 7 418.

(2) The second type of operation is the radical block dissection which includes the removal of the sternomastoid muscle and in that case the internal jugular vein. It is possible to remove both internal jugular veins provided an interval is allowed between the operations but it may lead to considerable [illegible].

Although the operation of block dissection is a long one it is not dangerous under modern conditions. Douglas gives the mortality as 3 per cent.

Recurrences after gland dissection of the neck. Diffuse recurrences are seen occasionally. They result from errors of judgment in selection of cases and mean that a gland dissection has been undertaken in an unsuitable case. This error is sometimes unavoidable as a rapidly progressing growth may produce implantation [illegible] in the tissues of the wound even though the original glands appeared to be easily operable. Diffuse recurrence leads to early death and treatment can be symptomatic only.

Localized recurrences are generally better excised if this is a technical possibility. It is important to be sure before undertaking excision of a recurrence that it is in fact a recurrence in the glandular area and not a direct outward spread from the tissues of the pharynx or base of the tongue. A considerable proportion of recurrent masses in the neck in the region of the angle of the jaw are really outward extensions from the primary growth. It is impossible to cure them either by operation or irradiation but while irradiation can be relied upon to delay their progress, operation is directly harmful because the excision cannot be extended to include the origin of the growth in the mouth or pharynx and any removal which is done is necessarily incomplete.

Prognosis of Carcinoma of the Mouth and Tongue

The outlook in these cases depends on the type of growth and the tendency to metastases as well as the stage of advancement at the time when the patient first seeks advice. The most reliable indication is the site and by considering this in conjunction with the clinical characteristics and the presence or absence of obviously infiltrated glands a reasonably accurate estimate can be made of the chances of cure. A short history is by no means always a favourable point in the prognosis as patients suffering from rapidly growing and highly malignant lesions come for treatment earlier than those with more chronic types of growth. Lesions which are infiltrating and non ulcerating can generally be kept in check for years by irradiation but they nearly always lead ultimately to death. An ulcerating growth which is mobile has a better prognosis than a similar one in which widespread induration is present in the surrounding tissues.

Estimation of prognosis by the microscopic structure of the primary growth is helpful up to a point for the surgeon knows that nearly all highly anaplastic growths have metastasized to the glands by the time the patient comes for treatment whereas if the growth is well

differentiated and localized, there is a good chance that the nodes are not involved.

Direct clinical evidence of glandular involvement whatever may be the site and structure of the primary growth reduces the chances of a five-year cure by at least 50 per cent. and if the primary growth is small and of recent appearance the presence of invaded glands means that the case is almost hopeless. Age has no great influence on prognosis but on the whole growths occurring in young people are more malignant than those which appear in later life

Prognosis according to the site of the primary growth. The tongue.—An unselected series of cases of carcinoma of the tongue treated by any efficient method may be expected to show a five-year survival rate of about 20 per cent. By eliminating advanced cases this figure may be improved to some extent but Butlin s 42 per cent of five-year cures has never been surpassed, and this may be taken as about the highest percentage attainable by rigid selection and energetic treatment The Manchester centre (Christie Holt) in 1941 showed a 30 per cent five-year survival rate for cases of carcinoma of the anterior two-thirds of the tongue. The Radiumhemmet figures for cases treated between 1916 and 1930 vary from 19 per cent. to 32 per cent according to the period A special point in estimating the prognosis in carcinoma of the tongue is the presence of syphilitic infection Carcinoma in a tongue which shows gross evidence of syphilitic infection is much more difficult to treat and carries a much *worse prognosis than a similar lesion occurring in an otherwise* normal tongue

The lip —Carcinoma of the lip is a comparatively benign lesion and a series of cases in which the glands are not obviously involved at the time of treatment may show a five-year survival rate of 90 per *cent or even more Cases with obviously involved* glands show a survival rate of 30 per cent to 40 per cent five years after treatment.

The floor of the mouth.—The results of treatment in this situation are more favourable than for growths of the tongue and less so than those for the lip A small series of personal cases shows a five-year *survival rate of 75 per cent. but the* figure is lower in larger series Cade* gives a five-year survival rate of 41 7 per cent. comparing with 22 6 per cent for the tongue Paterson† gives only 31 per cent in comparison with 30 per cent. for the tongue.

The cheek.—There is some difference of opinion regarding the *malignancy of these growths* In my experience they are comparatively benign and such figures as are available indicate that when the growth is seen and treated in its early stages a five year cure may be expected in well over 50 per cent of cases Advanced growths in this situation have a very bad prognosis. Paterson gives a 38 per cent. five-year survival rate in 38 cases

* *Proc. Roy Soc. of Med.*, 1947 xl, No. 7
† *Postgrad. Med. Journ.*, 1941 xvii.

Growths involving the jaws and alveoli – Several different types of growth occur in this situation and they are not sufficiently classified in any published figures to give much idea of the prognosis of any one type. It is certain that growths which infiltrate the lower jaw widely are hopeless unless a very wide excision is done. If the nature of the growth is recognized and the excision carried well beyond the limits of the growth the prognosis is good. Those which extend widely in and around the upper jaw can generally be improved by irradiation but few of them survive as long as five years. Localized papillary growths of the alveolus have a better prognosis provided they have not destroyed the bone widely, and in them the five year survival rate is probably about the same as it is in carcinoma of the tongue.

DISEASES OF THE SALIVARY GLANDS

ANATOMICAL AND PHYSIOLOGICAL CONSIDERATIONS

The parotid gland. The greater part of the parotid gland lies superficially on the ascending ramus of the mandible and between it and the mastoid process. Above it reaches to the zygoma and below it ends about the level of the angle of the jaw, behind which it comes almost in contact with the posterior end of the submaxillary gland. Its lower and posterior part overlaps the sternomastoid to a variable extent, and from its upper and anterior part a process runs forward across the masseter in company with the duct. The deeper part of the gland is irregular in shape and passes inwards between the ascending ramus of the jaw and the mastoid process towards the lateral wall of the pharynx. The glandular substance extends on either side of the styloid process, and is in contact on its deep surface with the internal carotid artery and the jugular vein. The external carotid artery enters the lower pole of the gland and passes deep to the facial nerve before dividing within the substance of the gland into its two terminal branches. The large veins corresponding with the internal maxillary and superficial temporal arteries unite within the gland substance to form the posterior facial vein. From this a branch passes anteriorly in the substance of the gland to join the anterior facial vein, while the posterior facial vein continues to leave the lower end of the gland as the commencement of the external jugular. Thus two large veins leave the lower border of the superficial part of the gland, the external jugular posteriorly and the communicating branch to the anterior facial farther forward. There are numerous smaller veins in the gland substance, many of which are large enough to cause bleeding sufficient to embarrass the operator.

The facial nerve enters the posterior part of the gland after leaving the stylomastoid foramen, crosses the styloid process and the external carotid artery, and divides into its branches of distribution on the ramus of the mandible. The branches run in the substance of the gland and leave it at various points on its anterior margin. The

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course and branches of the facial nerve and their relations to the parotid gland are subject to considerable variation The subject has been specially studied by McCormack and others* and earlier by McWhorter † The work of these and other investigators who have studied the subject more recently suggests that the parotid gland is generally formed of a superficial and deep lobe which are connected at the level of the lobe of the ear by a narrow isthmus. The deep lobe may be very small but in some cases it is equal in size to the superficial lobe The facial nerve after leaving the stylomastoid foramen passes downwards and a little forwards to enter the gland capsule and then divides into its two main divisions—the temporo-facial and cervico-facial branches These branches pass forward respectively above and below the isthmus of the gland and are in some cases united by an anastomotic branch in front of the isthmus The temporo-facial branch which is the larger of the two divisions runs forward just below the upper border of the parotid gland. The cervico-facial branch runs downwards and forwards in the line of the posterior border of the ascending ramus of the jaw giving branches of distribution from its anterior aspect. The temporo-facial branch is itself very short the branches of distribution leaving it in the manner of the spokes of a wheel radiating from the hub

In practice the isthmus seldom appears as a well-defined structure but the branches of the facial nerve are generally found to occupy a fairly well-defined plane which passes obliquely forwards and outwards from the point at which the facial nerve divides into its two primary branches The deep and superficial parts of the gland are connected by a number of vascular strands of parotid tissue which pass between the branches of the nerve The larger part of the gland lies in front of and superficial to the branches of the facial nerve and mixed tumours are generally found in this situation There are generally three or four branches of distribution below the zygoma. The highest is the buccal branch which lies superficial to the duct of the parotid gland. This branch generally originates from the temporo-facial division and if followed back into the gland substance will lead directly or indirectly to this division. Below the buccal branch there are generally two branches which emerge from beneath the anterior border of the gland and run forward over the masseter Both originate from the cervico-facial division.

When exposed from below the parotid gland presents two lobules a superficial one which overlies the sternomastoid and the masseter muscle and gives exit to the external jugular vein and the communication which runs to the anterior facial vein If these veins are divided and the lower extremity of the superficial portion is raised, the lower extremity of the deep lobe is exposed at the point where the external carotid artery enters it The lowest branch of the facial nerve lies between these two lobules and runs downwards parallel to the posterior

* *Surg. Gyn. Obst.*, 1945, LXXX, 620.
† *Anat. Rec.*, 1917 XII 149.

margin of the platysma as far as the level of the hyoid bone before turning upwards again to cross the lower margin of the jaw together with the facial vessels

The branches above the zygoma are difficult to define as they are covered by the thick temporal fascia The highest branch which supplies the muscles of the forehead runs almost horizontally very close to the upper margin of the gland

The parotid duct runs from the upper anterior part of the gland across the superficial surface of the masseter muscle At the anterior border of the muscle it turns sharply inwards and pierces the buccinator and after running obliquely between the muscle and the mucous membrane for a short distance it opens into the mouth just opposite the second upper molar tooth The course of the duct is indicated on the surface of the cheek by a line running from the lower border of the incisura intertragica to a point midway between the columella of the nose and the red margin of the lip

The parotid gland is enclosed in a very firm and unyielding fibrous capsule. At least one lymph gland lies within this capsule in intimate association with the substance of the gland

The submaxillary gland.—The submaxillary gland occupies nearly the whole of the submaxillary triangle of the neck and overlaps its lower boundary by half an inch or more It consists of a superficial portion which is enclosed in a firm capsule and lies on the surface of the mylohyoid and a deep portion which lies deep to this muscle on the hyoglossus and immediately beneath the mucous membrane of the floor of the mouth. The duct accompanies the deep portion of the gland and opens on a small papilla just to the outer side of the frænum linguæ The facial artery is embedded in the posterior part of the submaxillary and must generally be sacrificed when the gland is removed A number of lymph glands belonging to the submaxillary group lie within the capsule and nodules of lymphatic tissue are sometimes found embedded in the salivary tissue

The relation of the lingual nerve to the submaxillary gland is of considerable importance It lies on the surface of the hyoglossus about ½ in above the deep part of the gland and runs roughly parallel with the duct Before the duct opens into the mouth the lingual nerve loops round it passing first to the outer side of the duct and then beneath it The nerve is connected with the gland by the submaxillary ganglion and when the parts are matted together by inflammatory adhesions it is by no means easy to separate them Injuries of the lingual nerve have frequently occurred during excision of the gland and as division of the nerve leads to unilateral anæsthesia of the tongue it is a serious accident (*See* Fig 771 p 1907)

The sublingual gland.—This small gland lies beneath the mucous membrane of the floor of the mouth between the frænum linguæ and the body of the mandible It delivers its secretion into the mouth

External fistulæ of the submaxillary gland are extremely rare. They should be treated by excision of the gland Internal fistulæ in the floor of the mouth result occasionally from ulceration of stones into the mouth from the duct or incisions for their removal but they cause no symptoms and do not require treatment

INFLAMMATORY DISEASES

Acute inflammation of the parotid gland was at one time a much dreaded complication of abdominal operations Since the importance of frequent cleansing of the mouth has been understood the complication has become very rare but is still occasionally seen It nearly always occurs in patients whose general condition is poor and the prognosis is bad. Post-operative parotitis often leads to suppuration, but the external signs of pus formation are late in appearing owing to the thickness of the parotid capsule

Incision of parotid abscess.—If operation is delayed too long the abscess may burst through the lower end of the capsule and track beneath the sternomastoid towards the mediastinum with serious results so that the surgeon is well advised not to wait for fluctuation before making an incision Transverse incisions which are often advised as a means of avoiding damage to the facial nerve do not give very satisfactory drainage and it is better to incise the capsule vertically If the incision is made just in front of the lobe of the ear and is not carried deeply into the substance of the gland there is no danger of injury to the nerve but if pus is not found immediately beneath the capsule the search for it should be pursued with sinus forceps. The incision in the capsule may safely be carried up to the level of the zygoma.

Parotid abscesses which are incised by this method drain well, and the resulting scar is hardly noticeable In some cases instead of a localized abscess there is a diffuse purulent infiltration of the gland In these circumstances the lower end of the incision is turned forward 1 in. below the jaw as far as the anterior border of the masseter and the flap of skin so demarcated is raised so as to expose the surface of the parotid. Several transverse incisions are then made through the capsule in the line of the branches of the facial nerves and the gland substance is opened up by sinus forceps

It is worth noting that a subperiosteal abscess of the ascending ramus of the jaw gives physical signs almost identical with those of parotid abscess and if pus is not discovered within the capsule a search should always be made deep to it at the level of the outer surface of the bone

Parotid calculi.—Parotid calculi are rare but they occasionally impact near the orifice of the duct where they are palpable from the mouth. They are always small and often pass spontaneously If they do not the orifice of the duct should be enlarged by dilatation

or incision Even if the calculus cannot be extracted at once after this procedure it generally passes spontaneously within a few days

Calculi which impact farther back in the gland substance and those which remain impacted for a long period near the orifice of the duct give rise to chronic parotitis which is discussed below

Chronic suppuration in the parotid gland.—Chronic infection of the parotid gland often results from the presence of a calculus in the duct but parotid calculi are very small and often difficult to demonstrate. If a calculus can be demonstrated by physical examination or X rays near the orifice of the duct it should be removed. When no demonstrable calculus is present a sialogram may be done by injecting lipiodol into the orifice of the duct The X ray sometimes shows a generalized dilatation of ducts throughout the gland substance Sometimes it outlines the stone and sometimes shows a chronic abscess cavity produced by the ulceration of a stone through the wall of the duct The commonest site of impaction is just posterior to the anterior border of the masseter

The treatment of chronic parotitis is very difficult when no stone accessible from the mouth can be demonstrated. Even when there is strong evidence that a stone is present in the gland substance operative removal of the stone is not a promising form of treatment as it is likely to lead to an external fistula and generally the choice lies between purely conservative treatment and excision of the parotid X rays have been used with a view to stopping secretion in the gland but they are unlikely to influence the inflammatory changes favourably Payne* reports a case in which a considerable improvement was produced by auriculo-temporal avulsion.

Purely conservative measures include warmth massage of the gland dilatation of the duct and treatment with penicillin and chemotherapy By a mixture of these measures many patients can be kept moderately comfortable for a long period but many demand surgical treatment sooner or later because of severe pain or of abscess formation

The operation of parotidectomy for chronic parotitis is difficult and very tedious but it is generally possible to trace the branches of the facial nerve through the gland and to remove the gland completely without damaging the nerve This is undoubtedly the best treatment for chronic parotitis requiring operation but it should not be undertaken without warning the patient that damage to the facial nerve cannot be avoided with certainty

Chronic abscesses in the parotid gland sometimes present as ill defined tumours which are only a little tender The diagnosis between chronic abscess and carcinoma is very difficult to make though a localized dilatation in a sialogram suggests an inflammatory lesion rather than a neoplasm

Submaxillary calculi.—Submaxillary calculi may occur in any part of the duct or in the substance of the gland itself They may

* *Proc Roy Soc Med.*, 1938, xxxi, 306.

become impacted just behind the orifice of the duct and if they cause ulceration of the mucous membrane in this situation the ulcer is easily mistaken for carcinoma of the floor of the mouth A stone in this situation can be extracted without difficulty by making an incision in the mucous membrane over it the wound being left unsutured.

More commonly stones are found farther back in the duct in the region of the anterior molar tooth. These stones also should be extracted through the mouth but unless the operation is undertaken deliberately and in favourable surroundings it may be very difficult *General anæsthesia is preferable as the œdema produced by local* infiltration may make it difficult to locate the stone A stitch should be inserted deeply behind the stone to prevent it from slipping backwards and after localizing the exact position a longitudinal incision should be made in the line of the duct over the site of impaction This is most easily done with a diathermy needle passed before the current is turned on into the tissues of the floor of the mouth until it is felt to touch the stone With the current in operation the needle is lifted outwards so that the tissues overlying the stone are cleanly divided and as there is no bleeding the stone can easily be seen and extracted. Performed in this way the operation only takes a few minutes but if it is carelessly done and the incision is made before the position of impaction is exactly localized the field becomes obscured by blood and the operator may have considerable difficulty in finding the stone.

It occasionally happens that a stone which is not impacted causes dilatation of the duct The stone in this case is usually small and freely mobile and in consequence cannot be felt with certainty through the mucous membrane. In these circumstances it is better to expose and open the duct and search for the stone from *within* In doing this it must be remembered that the duct lies on the hyoglossus and the incision for its exposure must be made only a little outside the line along which the mucosa of the floor of the mouth is reflected on to the under surface of the tongue

Wounds resulting from the removal of stones in the submaxillary duct should always be left open as infection is very often present and suture may lead to spreading sepsis in the tissues of the floor of the mouth

A most difficult decision faces the operator when the stone is impacted far back in the commencement of the duct In this position it can sometimes be felt and extracted through the mouth in the same way as one which is impacted more anteriorly but as infection is nearly always present and the gland itself is enlarged extraction of the stone does not always relieve the symptoms In cases of this type New and Harper* found that recurrence of symptoms took place in 23 per cent of patients as compared with 18 per cent when the stone was impacted anteriorly

If the gland is not obviously enlarged to external palpation it is right to try the effect of removing the calculus through the mouth.

* *Surg. Gyn. Obst.*, 1931 liii, 456.

If the gland is considerably enlarged it is wise to explain matters to the patient and if he or she is anxious to avoid an external scar the calculus may be removed locally but only on the understanding that subsequent removal of the gland may be necessary If early and complete relief of symptoms is the primary consideration removal of the whole gland through the neck is preferable

When the gland is severely infected and grossly enlarged or when calculi are present in it which cannot be felt from the mouth there is no doubt that the gland should be completely removed through an external incision The operation is not easy because of the widespread inflammatory fibrosis and œdema which surround an infected gland but the late results are excellent

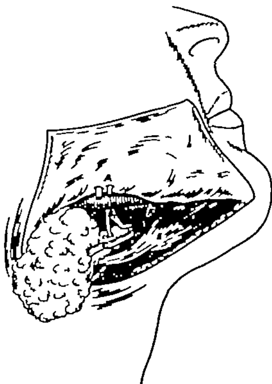


Fig 771 —Excision of submaxillary salivary gland. The superficial part has been freed from the lower border of the jaw and the mylohyoid and turned back over the posterior belly of the digastric.

A, facial vessels divided where they cross the jaw B, lingual nerve. C, duct of submaxillary gland and deep part of gland. D, hypoglossal nerve. E, digastric muscle —anterior belly F mylohyoid.

Removal of submaxillary gland —The incision should start one inch behind the anterior border of the sternomastoid and about two inches below the tip of the mastoid process and curving downwards in its middle nearly to the hyoid should extend anteriorly to about one inch behind and below the symphysis menti It is important not to carry it up between the sternomastoid and the angle of the jaw as this nearly always produces a partial paralysis of the lower lip by dividing the lowest branch of the facial nerve The incision is deepened at once through the superficial fascia and the platysma and the flap so formed is turned upwards until the lower border of the jaw is exposed The facial vessels are divided as they leave the submaxillary gland deep to the platysma and the upper border of the submaxillary gland is freed in its whole extent in a plane deep to the platysma A number of large veins are generally encountered on the external surface of the mylohyoid as the middle line is approached

Turning to the posterior extremity of the gland the gland is retracted forwards and the sternomastoid backwards. The gland is then freed from the stylo-mandibular ligament which separates it from the parotid and the common facial vein is divided Next working between the gland and the posterior belly of the digastric the facial

artery is defined and ligatured close to its origin from the external carotid. It is now best to turn to the anterior part of the wound and free the superficial part of the submaxillary from the mylohyoid, so that on retracting this muscle the gland is left attached by its deep part and its duct only (Fig 771) These are traced across the outer surface of the hyoglossus and carefully separated above from the lingual nerve before the duct is divided There is usually a fair amount of bleeding and drainage is necessary

The operation may leave a weakness of the lower lip even when the incision described above is used The weakness results in a raising of the lower lip on the affected side which makes the mouth asymmetrical The deformity very rarely persists longer than a few months but it is well to warn patients that it may occur The explanation of this occurrence is uncertain Some surgeons attribute it to division of the platysma but it is probably more often due to the division of some fibres of the cervical branch of the facial nerve either at the point where it leaves the lower end of the parotid or more often where it turns upwards to cross the border of the lower jaw close to the facial vessels

Tumours of the Salivary Glands

New growths which are generally referred to as mixed salivary tumours occur fairly commonly in the lower part of the parotid and occasionally in the submaxillary gland. Judged by their clinical characteristics these tumours are typically innocent for they are sharply defined and completely encapsulated. The after history of operated cases throws some doubt on their innocence and in dealing with them the surgeon should keep in mind that the recorded recurrence rate after operation is extremely high (46 per cent in some collected figures) and that post-operative recurrences generally grow more rapidly than the primary tumour and are often frankly malignant The frequency of recurrence suggests either that a high proportion of apparently innocent tumours have already undergone malignant degeneration before operation or that outlying portions of the tumour are frequently overlooked and so escape removal These considerations raise the question of whether it is ever justifiable to remove an encapsulated parotid tumour by enucleation alone. This depends upon the type of the tumour its size and its situation in the gland substance. A small tumour which is regular in outline and lies in the superficial part of the lower extremity of the gland may safely be removed by enucleation. Tumours which are irregular in shape and those which lie more deeply in the gland substance are very difficult to remove by this method without running the risk of puncturing the capsule or leaving behind one of the small irregular extensions of the tumour Large tumours are sometimes easy to remove if they are on the superficial surface of the gland but many large tumours extend forwards deep to the ramus of the jaw and are very difficult to

remove intact by enucleation. Enucleation alone should be reserved for small tumours which are regular in outline and lie in the superficial part of the gland at its lower extremity.

Enucleation combined with irradiation.—Some surgeons make a practice of giving a pre-operative course of irradiation before attempting to remove a parotid tumour by enucleation. By producing a small amount of œdema around the capsule, preliminary irradiation facilitates enucleation, and it is said* to reduce the size of the tumour and increase the thickness of the capsule. Mixed parotid tumours are generally highly resistant to the influence of irradiation and, although it is believed by some surgeons that pre-operative irradiation reduces the incidence of post-operative recurrence, it is very difficult to prove this theory. Patey† quotes figures from various sources in its support.

Other surgeons rely on post-operative irradiation either by insertion of radium needles immediately after operation or tele-irradiation after the wound has healed. Tod gives the figures at the Holt Radium Institute as 98 per cent. of five-year cures in 52 cases for operation followed by interstitial irradiation. The writer believes that there is not sufficient evidence that irradiation is capable of destroying portions of mixed parotid tumour left behind by incomplete excision to justify a surgeon in relying on supplementary irradiation to prevent recurrence when he has reason to believe that tumour cells may have been left behind. Thus, in my opinion, if irradiation is used at all in mixed parotid tumours, the irradiation should be pre-operative and the operation should be designed to avoid the risk of leaving tumour cells behind, i.e. that tumours which are too irregular or deeply placed to make enucleation a safe and reliable procedure should be treated by more extensive operation and not by enucleation followed by irradiation.

Irradiation alone gives very poor results in mixed parotid tumours and should not be used.

Removal of mixed parotid tumours by measures other than enucleation.—Nearly all mixed parotid tumours originate in the superficial part of the gland, superficial to the facial nerve, and in most cases it is possible by making a correct approach to excise the tumour together with a portion of the surrounding gland tissue without endangering any of the main branches of the facial nerve. Thus local excision together with sufficient surrounding gland tissue to ensure that the capsule of the tumour is not directly handled is the operation of choice in most parotid tumours which are not suitable for enucleation. Tumours which originate in or extend into the deep portion of the gland require operation on the lines indicated in a later paragraph.

Technique of excision.—Small superficial tumours are often approached through a transverse incision which runs parallel with the main

* R. T. Payne, 1943, *Lancet*, ii, 111.
† *Brit. Journ. Surg.* 1941, xxviii, 34.

branches of the facial nerve This operation is not very satisfactory as it does not provide for the case in which the tumour proves at operation to be more extensive than it appeared on pre-operative examination and I now use it very seldom A much better exposure can be achieved by an incision which starts immediately in front of the external auditory meatus and continues down as far as the angle of the mandible Two variants on this incision are employed (1) by curving the lower end of the incision backwards below the lobe of the ear on to the mastoid and then down in the line of the sternomastoid and (2) a prolongation downwards and forwards to the anterior border of the masseter about a finger s breadth below the lower border of the jaw A third variant which is sometimes used is a Y-shaped incision with the two limbs of the Y extending up in front of and behind the pinna respectively and the stem down from the lobe of the ear along the anterior border of the sternomastoid. The simple straight incision with no variation is suitable for a tumour which can be enucleated with safety The skin is turned back to expose the capsule of the parotid in the region of the tumour and it is then incised transversely to expose the surface of the tumour Thereafter dissection must be pursued with extreme care as rough handling of the tumour or even grasping the capsule with toothed forceps may cause the capsule to rupture and allow the escape of tumour cells into the raw tissues of the wound. Tumours which are superficial and moderately regular on the surface can generally be shelled out without much difficulty by a combination of blunt and sharp dissection without the necessity of grasping the capsule with forceps. Such tumours lie completely superficial to the facial nerve and neither the main nerve nor any of its branches is seen during the course of the operation.

If the tumour proves to be larger and more deeply situated than it appeared by *the pre-operative examination the operation* must proceed to a formal exposure of the lower lobe of the gland as described below

If it is desired to treat the bed of the tumour by post-operative interstitial irradiation the radium needles should be inserted around the tumour bed through separate skin punctures. They should never be placed actually in the cavity left by the removal of the tumour nor should their strings be brought out through the main incision The needles should be inserted about one-third of a centimetre away from the bed of the tumour and the dose should be calculated to be distributed over seven or eight days

Excision of mixed parotid tumours after freeing the superficial lobe of the parotid gland.—The appropriate incision varies with the situation of the tumour and the size of the gland I prefer an incision starting over the mastoid process and running downwards over the surface of the sternomastoid to the lowest point of the parotid gland and then curving forward below the angle of the mandible to the level of the anterior border of the masseter If this incision is

used the lower pole of the parotid is approached from behind after deepening the upper part of the incision sufficiently to expose the superficial surface of the sternomastoid muscle behind the gland The plane of the surface of the sternomastoid is then followed forward and the parotid gland is lifted forward and outward still attached superficially to the skin of the upper flap As the dissection is prolonged forward the external jugular vein is encountered emerging from the lower border of the gland and the vein is divided and ligatured. A little farther forward another large vein which runs from the parotid gland to the anterior facial vein is encountered and is similarly dealt with It is now possible to retract the sternomastoid backwards and expose the posterior belly of the digastric and separate it from the posterior surface of the parotid gland. By lifting the gland still farther out by means of traction on the upper anterior flap the superficial lobe can be separated from the outer surface of the masseter and from the stylo-mandibular ligament which separates it from the posterior extremity of the submaxillary gland. If the sternomastoid is now drawn backwards and the superficial lobe of the parotid gland forwards the external carotid artery can be seen entering the lower pole of the deep portion of the gland

The tumour generally lies in the superficial part of the gland and in this case the lowest branch of the facial nerve is displaced forwards In these circumstances it is quite safe to approach the tumour from behind by incising the parotid tissue over it and to follow the plane of separation provided by the capsule of the tumour The lowest branch of the facial nerve is often very close to the tumour capsule anteriorly The main danger of this method arises from the fact that many tumours are more extensive than they appear on clinical examination and some which seem to be superficial are found to extend deeply beneath the ascending ramus of the jaw If a tumour approached by the above method is found to extend farther forwards and upwards than was anticipated the upper part of the parotid must be mobilized by freeing it from the mastoid process and the anterior surface of the auditory meatus before any attempt is made to free the upper and deeper attachments of the tumour The fact that the tumour has extended upwards does not alter its relationship to the facial nerve and in nearly every case it will be found that the branches of the facial nerve lie deep to the tumour and in front of it They are often very close to the capsule of the tumour anteriorly and it may be necessary to work in a plane immediately outside the capsule in order to avoid damage to the branches of the nerve. Drainage is usually necessary

Exposure of tumours in the upper or deep portion of the parotid gland.—The above operation serves excellently for the majority of mixed salivary tumours but it does not serve for those which lie very high in the gland or deep to the branches of the facial nerve In such tumours satisfactory excision can be achieved only by an operation which is designed deliberately to expose the facial nerve Several

methods are available for exposing the facial nerve and it is impossible to say in advance which of them will prove the most feasible in any particular case. In short the methods available are —

1 Exposure of the buccal branch after reflecting forwards the parotid fascia to expose the antero-superior portion of the gland at the point where the parotid duct leaves it. The buccal branch should be discoverable superficial to the duct at or a little below the line of the zygomatic arch This branch followed backwards leads to the temporo-facial division of the main nerve or else to a point on the front of the isthmus of the gland where the temporo-facial and cervico-facial divisions anastomose

2. The infra mandibular branch of the nerve can be exposed as it runs below and behind the angle of the jaw in the loose tissue behind the posterior border of the platysma. If this branch can be identified and followed back it will be found to run in nearly every case deep to the superficial lobe of the parotid and to lead to the cervico-facial division of the nerve below the isthmus of the gland The main trunk of the nerve can then be identified and protected This operation is best performed through a Y shaped incision the limbs of the Y starting respectively behind and in front of the ear and its stem running downwards in the line of the sternomastoid. The lower pole of the parotid is left attached to the anterior flap and lifted forward with it thus exposing the loose tissue deep to the pole in which the nerve runs until it emerges into the superficial tissues at the point where the facial vessels cross the mandible

3 James* describes a method of approaching the trunk of the nerve in the first instance instead of its branches He draws attention to the fact that when the head is tilted back and turned away from the operator the main trunk of the nerve runs more directly forward than it does with the head in the mid position. He makes an incision starting over the base of the mastoid process and carries it downwards and forwards for 3 in or more making an accessory incision in front of the pinna in some cases. The anterior border of the sternomastoid is exposed and part of its attachment to the mastoid process is divided to expose the posterior belly of the digastric. The tumour is turned forwards and the tip of the styloid process and the transverse process of the atlas are identified by palpation. Dissection is then carried upwards along the anterior border of the digastric by the blunt method to expose the main trunk of the facial nerve at or just anterior to the stylomastoid foramen. If the tumour is wedged between the jaw and the mastoid process exposure is improved by removing a portion of the process with an osteotome Dissection is now carried forward the various branches of the nerve being identified.

This description is quoted from an article by James.

Mixed tumours occurring in the submaxillary gland should be

* Surg Clinics N Amer Oct., 1943, p 1439.

treated by excision of the whole gland The operation is not followed by any disability and ensures complete freedom from recurrence

Malignant tumours of the salivary glands.—The parotid is affected much more often than the submaxillary Carcinoma of the parotid appears sometimes as a superficial growth involving the lower part of the gland and producing early ulceration but more often as a deep infiltrating tumour Some infiltrating tumours arise in the position from which an encapsuled tumour has been removed previously There is some doubt as to the frequency with which malignant tumours arise in previously encapsuled tumours which have not been surgically treated Patey* states that While spontaneous malignant change in untouched mixed parotid tumours may occur its occurrence is so rare that for practical purposes it may almost be dismissed. Ewing † referring to carcinoma of the parotid gland states that in a great majority of cases a quiescent tumour has long preceded the development of an active growth and recent figures from the British Empire Cancer Campaign support this statement by giving particulars of 11 cases of carcinoma of the parotid gland in 6 of which a tumour had been present for more than a year and in 8 for more than five years It is a point of interest that in some series of figures the age incidence of carcinoma of the parotid is early in comparison with other carcinomata of the mouth and neck Thus Benedict and Miegs‡ record 29 cases 16 of whom were below the age of 50

Even in the absence of pathological proof which is obviously difficult to obtain it is certainly not safe to assume that carcinoma of the parotid cannot arise in an untouched mixed tumour

Malignant tumours of the parotid are rare and it is probable that many different types of growth are represented among the cases in published series. There is no doubt that in these series those cases recorded as carcinomata vary from apparently localized tumours which on microscopic examination have shown infiltration of the capsule to tumours which have never shown any sign of encapsulation and have spread rapidly throughout the parotid substance In these circumstances statistics referring to the efficacy of various forms of treatment are misleading and it is sufficient to say that there are many cases on record of five year survival of patients treated by operation for proved carcinomata of the parotid and that excision of the parotid is therefore well worth undertaking in cases which show no evidence of direct spread beyond the capsule of the gland.

The results of treatment of carcinoma of the parotid gland by irradiation alone are generally disappointing Benedict and Miegs reviewing 29 cases of carcinoma state that radium and X rays are useful as a palliative measure only Ahlbom§ states that about 58 per cent. of malignant salivary tumours show some degree of radiosensitivity and that in 16 per cent. the sensitivity is marked He attempts to relate

* *Brit Journ Surg* 1940, xxviii, 31
† Neoplastic Diseases, 1940, Philadelphia W B. Saunders.
‡ *Surg. G Obst.*, 1937, lx, 620
§ *Acta Radiol. Suppl.*, 1935, No. 23

these characteristics to the histological structure and comes to the conclusion that most of the radio-resistant growths are of the squamous-celled and adeno-carcinoma type As elsewhere growths which increase rapidly in size generally react better to irradiation than do those which have appeared and grown more slowly

According to Ahlbom s figures five year cures are obtained by irradiation in about 50 per cent of operable cases and 23 per cent. of a complete series. Figures collected by the British Empire Cancer Campaign in 1930 show six cases of proved carcinoma treated by radiotherapy alone with one five-year survival

Surgery alone should be used for small malignant tumours when it appears that excision of the parotid gland will remove the tumour with a reasonable margin of surrounding tissue.

If such tumours present with a very short history it may be worth while to irradiate them on the supposition that one is dealing with a rapidly growing and radiosensitive tumour in its very early stages but in cases in which it is known that the growth has occurred in a place which has been occupied by an apparently non malignant tumour for some years and in those where the growth follows removal of a mixed tumour the chances of any significant response to treatment by irradiation are too small to justify its use Large diffuse tumours which *distend the capsule of the parotid and those which appear to have* transgressed the capsule at any point should be treated in the first instance by radiotherapy a decision being reached at a later stage as to whether subsequent operation shall be performed or not. As in other regions over irradiation and irradiation of recurrences in a previously irradiated area are disastrous. It is equally disastrous to attempt removal of a tumour which has invaded surrounding tissues to an extent which makes radical operation impossible Thus there is a proportion of malignant parotid tumours including most recurrences after extensive irradiation and after total parotidectomy which are untreatable and should be recognized as such.

Operations for excision of the parotid gland for malignant disease.—The posterior part of the parotid gland must necessarily be approached across the upper deep cervical lymphatic field and it is therefore impossible to treat the removal of the primary tumour and the clearance of the lymphatic field as two separate operations and the operation for removal of the primary tumour must be designed to include clearance of the lymphatics at least in the upper part of the neck The operation is one of considerable magnitude If there are no obvious metastases in the deep cervical chain the operator may consider it justifiable to limit the dissection at the lower end to the nodes above the omohyoid, but if the lymph nodes are clinically involved the aim should be to combine excision of the parotid with a complete block dissection of the neck on the affected side

Incision.—The operation should be commenced by making the conventional incision for block dissection of the glands of the neck the

main incision extending from the mastoid process to the lower end of the sternomastoid running a little in front of the posterior border of the muscle and an accessory incision running from the point of the jaw to meet the main incision about the level of the hyoid To provide for adequate approach to the parotid an additional incision must be made starting immediately in front of the ear a finger s breadth above the zygoma and running downwards to curve beneath the lobule of the ear into the main incision.

The operation is commenced by dissecting backwards from the main incision in the subcutaneous plane to expose the posterior border of the sternomastoid and to divide the numerous small vessels which emerge from beneath the muscle and pass to the cellular tissues in the posterior triangle. The upper attachments of the sternomastoid should then be divided to expose the upper end of the splenius capitis at its insertion into the mastoid process The anterior border of the sternomastoid is now defined in the lower part of the incision by turning the lower anterior flap towards the midline The upper anterior flap is now raised to expose the surface of the submaxillary gland as far as the lower border of the jaw The dissection is carried upwards in front of the ear to expose the parotid capsule remembering that the lower pole of the parotid gland lies very close beneath the skin on the superficial surface of the sternomastoid behind the angle of the jaw Dissection at this point must be carried on in a plane immediately deep to the skin As this flap is raised the facial vessels are divided at the point where they cross the lower border of the mandible and the external jugular and the communicating vein which runs from the lower end of the parotid to the anterior facial are both divided at the lower extremity of the parotid gland

It is now necessary to expose the great vessels of the neck beneath the upper end of the sternomastoid. This is most easily accomplished by following the posterior belly of the digastric muscle which is so far obscured by the submaxillary gland The operation is facilitated by removing the contents of the submaxillary triangle at this stage To do this it is necessary first to define the gap between the submaxillary and the parotid glands retracting the lower pole of the parotid back with the sternomastoid while the submaxillhary is pulled forward This opens up the space which leads down to the styloid process and the transverse process of the atlas. The submaxillary triangle is then cleared the posterior extremity of the gland being first freed by dividing in turn from above downwards the attachments to the stylo-mandibular ligament the facial artery and the common facial vein The submaxillary gland is then freed anteriorly from the mylohyoid where a number of veins require division and ligature and the whole gland is drawn downwards while the mylohyoid is drawn forwards to expose the deep part of the gland At this stage in the operation the lingual nerve is defined as it runs parallel to the deep portion of the gland and about one-third of an inch above it and is freed from the gland by dividing the nerve fibres which run to the

submaxillary ganglion The submaxillary duct is then divided and the gland turned backwards exposing the tissues in the base of the submaxillary triangle It is now necessary to divide the anterior tributaries of the internal jugular vein including the superior thyroid and lingual veins. The vein can now be drawn backwards with the sternomastoid and by following the posterior belly of the digastric the operator is led to the transverse process of the atlas where the spinal accessory nerve crosses the jugular vein The jugular vein is defined and divided between ligatures at this point The origin of the external carotid artery is now located just below the posterior belly of the digastric. The hypoglossal nerve which crosses the artery at this point is pulled aside and the external carotid artery divided between ligatures close to its origin from the common carotid The tendon of the digastric muscle is then divided and its posterior belly turned backwards This completes the exposure of the styloid process and the posterior surface of the parotid glands and the gland with the upper portion of the external carotid artery can now be pulled forward It may now be possible to expose the trunk of the facial nerve between the point where it leaves the stylomastoid foramen and that at which it enters the capsule of the parotid. With the head in its normal position the nerve runs almost vertically from the foramen to the gland capsule but rotation of the head causes *it to run obliquely* Many methods of conserving the facial nerve have been described recently but in my opinion no attempt at conservation is justifiable in an infiltrating malignant tumour and the nerve should be deliberately divided and sacrificed at this point if the tumour is of the type which tends to infiltrate the whole substance of the gland. If the tumour is a localized one which has originated in the superficial lobe of the gland it may be justifiable to make an attempt to spare some or all of the nerve If the operator decides to take this step he should follow the course of the nerve into the capsule remembering that it divides almost immediately into its temporo-facial and cervico-facial branches. Division of the cervico-facial branch does not lead to a very severe deformity and if the tumour is in the lower part of the gland the cervico-facial branch may be divided and the temporo-facial branch pulled upwards to expose the part of the gland which lies deep to the plane in which the facial nerve runs

The peripheral attachments of the superficial lobe of the parotid must now be divided. If an attempt is being made to save the temporo-facial division of the facial nerve this trunk should be followed to the point where it splits up into its branches of distribution and the individual branches should be dissected out starting with the most posterior and tracing each branch until it is no longer connected with the parotid gland. As the branches are traced the fascia around the upper and anterior borders of the gland is divided, the superficial temporal artery being isolated and divided separately The parotid duct will be found leaving the gland at or a little below its apex just below the level of the zygoma. The buccal branch of distribution

of the facial nerve lies superficial to the duct The duct is divided at this point and the anterior border of the gland is followed down to the point where it crosses the horizontal ramus of the jaw If the operator is making an attempt to save the branches of the cervico-facial division of the nerve he must identify these as they leave the capsule of the gland on the surface of the masseter

It is to be noted that attempts to save the facial nerve or any of its branches are by no means always successful and certainly no such attempt should be made if it appears that it will prevent the operation from being truly radical A non radical operation leaves the patient ultimately with a recurrence which will certainly infiltrate the branches of the facial nerve and produce the facial paralysis which the operator was trying to avoid

If it is decided to make no attempt to save the facial nerve the trunk of the nerve is divided as soon as it is seen entering the posterior part of the capsule. The operator then proceeds to free the periphery of the gland above the zygoma and to follow it forwards and downwards The gland is then stripped up from the masseter until the posterior border of the ascending ramus of the jaw is reached The gland is now attached only by its deep portion which is bounded posteriorly by the cartilage of the auditory meatus and the mastoid process and anteriorly by the temporo-mandibular joint and the neck of the mandible The mouth is gagged widely open The gland is freed from the cartilaginous meatus and an attempt is made to dislodge it from its bed remembering that the internal maxillary artery leaves the gland just behind the temporo-mandibular articulation and is likely to bleed considerably from its distal end although the external carotid has been ligatured previously If the difficulty of dislodging this portion of the gland proves too great the masseter may be elevated from the superficial surface of the ascending ramus of the jaw and a vertical strip of bone removed together with the neck of the bone and the condyle

This step should be necessary only on rare occasions as the greater part of the deep portion of the gland is accessible from behind and below where the sternomastoid has been stripped from the mastoid process

The parotid gland the sternomastoid and the internal jugular vein are now turned downwards and removed together with the lymphatics surrounding the vessels of the neck as far down as the point at which the omohyoid crosses the carotid sheath

Irradiation for carcinoma of the parotid.—External irradiation appears to give good results at Radiumhemmett but interstitial irradiation can be used if the facilities for tele-irradiation are not available If interstitial irradiation is used the needles must be distributed with regard to the complicated shape of the gland and its irregular extensions. The proximity of the compact bone of the upper jaw makes it particularly important to avoid overdosage as radio-necrosis in this situation is extremely painful and quite incurable

Treatment of glandular areas.—Glandular metastases develop at some stage in the progress of malignant tumours in a considerable proportion of cases (Ahlbom—50 per cent) Palpable metastases should be treated by block dissection which should be combined with removal of the primary tumour in cases which are treated by surgery and performed as a separate operation if the primary tumour has been controlled by irradiation

As both local recurrence and distant blood borne metastases are commoner than invasion of the lymph nodes prophylactic gland dissections in cases where the lymph nodes are not palpable are not justifiable except when the primary tumour is treated by operation on the lines described above and the approach to the primary tumour has to be made across the lymphatic field.

Recurrences in the posterior triangle are common after treatment of malignant parotid tumours either by operation or irradiation and this site should be examined frequently and carefully in follow up cases

Malignant tumours of the submaxillary gland.—Such tumours are very rare They should be treated by excision if they are technically operable and the operation differs little from the routine block dissection for malignant glands of the neck. It must be remembered that secondary tumours in the region of the submaxillary gland are fairly common and the possibility that a tumour with the characteristics of a carcinoma in the submaxillary region is a blood borne secondary from some remote primary growth must be remembered.

CHAPTER XXXIV

HARE-LIP AND CLEFT PALATE

By W E M WARDILL

The subjects of hare-lip and cleft palate are so intimately connected that it is impossible to consider one without wandering into the province of the other For purposes of description however three main types (as described by Ritchie) * may be selected namely —

A. Pre-alveolar clefts in which the lip or lip and nostril alone are split (Fig 772 A.)

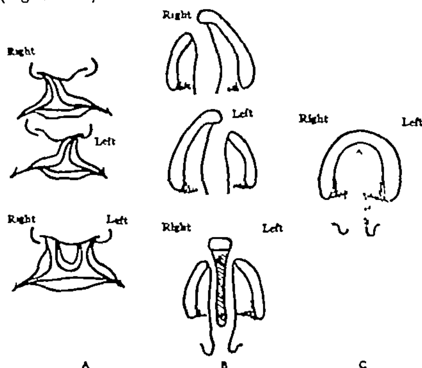


Fig 772 — A, Pre-alveolar clefts, right, left and bilateral. B Alveolar clefts, right, left and bilateral. C, Post-alveolar cleft.

B Alveolar clefts where the split involves the lip alveolus and palate. (Fig 772 B)

C Post alveolar clefts in which the palate alone is cleft. (Fig 772 C)

In pre-alveolar and alveolar clefts the lesion may be unilateral or bilateral

Anatomical and Physiological Considerations

In general it may be stated that clefts of the lip and palate are associated with changes in the architecture not only of the underlying bones but of the whole skull.

A. Pre-alveolar cleft —This type affects the lip or lip and nostril alone. It varies in extent from a small notch in the red margin to a complete split which involves the floor of the nostril but does not

* Arch. Surg Apr 1934 xxviii, 617 ff.

extend through the alveolus Despite the apparent truth of this Broderick has shown that X ray examination of the upper jaw in such cases frequently reveals a definite cleft of the bone although the over lying soft tissues appear to be in the normal relationship The im portance of this observation lies in the fact that even with the simpler types of cleft underlying bone changes may cause persistent de- formity after repair

It has been my practice in dealing with these pre-alveolar clefts to defer operation in the simpler types until the age of about a year In the more extensive types where there is associated flattening of the nostril it is better to carry out the operation if possible within the first three months of life During the course of repair the muscle of the lip is restored and its sphincter like action has the effect of remodel ling any abnormalities in the skull bones. Moreover these bones can at this time of life have their architecture altered very simply by the natural activities of the lip muscles and other soft tissues.

The aim in the repair of the lip is of course to secure as far as possible a cosmetic result and this object is more easily attained where function is made the first consideration. This being so it can be said quite definitely that a result obtained at one operation can never be permanent because of the alteration which takes place in the whole of the face and jaws and it is well to promise nothing more than this leaving any secondary cosmetic adjustment which may be necessary to a second operation

B. Alveolar cleft.—In this type which passes through the alveolus to one or other side of the premaxilla changes in the structure of the skull are more obvious. Where the cleft is unilateral the vault of the skull is asymmetrical the frontal and parietal eminences on the side of the cleft being displaced backwards in relationship to the opposite side. In addition the upper jaws are splayed apart and the nasal septum including the vomer is displaced to the side away from the cleft Very frequently the maxilla on the side of the cleft lies posterior to that of the opposite side The premaxilla is consequently rotated away from the cleft so that restoration of the dental arch is difficult and sometimes impossible Where the alveolar cleft is bilateral, both upper jaws are displaced posteriorly and the premaxilla is mounted on a strong buttress of vomer Frequently the premaxilla is also rotated to one or other side or displaced upwards Restoration of the dental arch once again is either extremely difficult or impossible.

In alveolar clefts second only in importance to the repair and consequent utilization of the lip muscle is the formation of a floor to the nose and naturally this cannot be effectively carried out unless the hard palate defect is repaired at the same time. This also has the advantage of making subsequent repair of the palate much simpler and more certain in fact if this treatment is surgically successful little more than a soft palate cleft remains for later treatment. It is to Victor Veau* that we owe the credit for this procedure and his

* Division Palatine, Masson et Cie Paris.

operation has certainly proved invaluable The principle of Veau s method consists in raising the muco-periosteum of the hard palate on the cleft side and suturing it to a previously prepared flap from the muco-periosteum of the vomer

It is important to realize in dealing with this type of cleft that early operation is indicated in order that the moulding process supplied by the muscles and other soft tissues should have its maximum effect It is also important to realize that the pull of living tissues is far more effective in reconstructing such bone deformities than either the excision of portions of the vomerine buttress or removal of the premaxilla If bone is removed flattening of the upper lip with ugly deformity is inevitable Fig 778A shows the type of deformity which necessitates

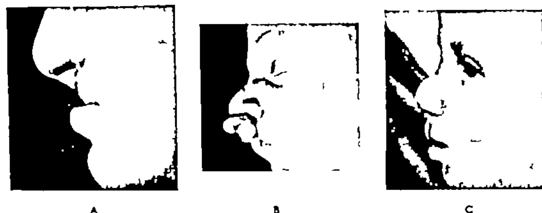


Fig 773

A, gross deformity of the lip following excision of the premaxilla or of part of the vomer B, bilateral alveolar cleft before operation. C, same case as B eight months after repair of both sides of lip and floor of nose. X attempt made to replace premaxilla by removal of bone. Note natural lateral contour of the upper lip.

subsequent operation for the correction of an extremely unsightly lip On the other hand the premaxilla does not always come into a natural relationship with the jaws even in spite of early operation but in such circumstances there is nothing to prevent its correction at a later date The degree of moulding which can be effected in these cases is illustrated by Figs 778B and C

C. Post alveolar cleft.—These clefts involve the velum to varying degrees and can extend along the hard palate as far as the alveolar margin. In most cases the dental arch is regular suggesting that there are no changes in the shape of the skull Such however is not the case as is seen in Fig 774 which demonstrates the flattening of the face which occurs with an uncorrected post alveolar cleft involving the bone of the hard palate The appearance is quite characteristic and the face almost Mongolian In such clefts the upper jaws are splayed apart and measurements conducted by myself some years ago demonstrated this fact * The importance of the splaying apart of the maxillæ lies in the fact that there is an associated increase in the lateral diameters of the naso-pharynx I believe but have never been able to prove by actual measurements that there is also an increase in the

* *Brit. Journ. Surg.*, 1929 xvi, 127

antero-posterior diameter This fact is of paramount importance since the aim of treatment of cleft palate is to construct a palato-pharyngeal sphincter mechanism that is a mechanism which during speech separates the oral and nasal cavities *so that air cannot escape through* the nose and thus give rise to the characteristic cleft palate speech.

There is in addition in post alveolar clefts some paucity of soft tissues The tensor palati muscles which have never been fully put into use are naturally shortened. Consequently attempts to re-suture the palate in the mid line bring inevitable tension on these muscles The palate thus tends to become fixed and immobile from the bow string like action of these two tendons which hook around the hamular processes The tensor palati is *essentially a muscle of deglutition* its principal function being to expel the bolus over the back of the tongue very much in the same way as an orange pip can be squeezed between the fingers It also acts in conjunction with the palato-pharyngeus and palato-glossus muscles in drawing the palate away from the posterior pharyngeal wall. Putting the tensor out of action seems to be associated with no functional disability



Fig 774 – This patient has a wide unrepaired post-alveolar cleft. Note breadth and flattening of face.

The muscles which are responsible for closing the naso-pharynx and *forming the sphincter mechanism are the levators* which raise the palate upwards and backwards towards the pharyngeal wall and the superior constrictor muscle which acts synchronously with the levators and produces a ridge on the posterior pharyngeal wall, thus completing the sphincter mechanism This latter muscle acts not only in producing a ridge (ridge of Passavant) but also in narrowing the diameters of the naso-pharynx from side to side. Evidence of the competence of this sphincter is seen in the ability to inflate balloons and to snort as in clearing the pharynx of naso-pharyngeal mucus Neither of these functions is possible to the patient with an unrepaired cleft of the palate or in whom as a result of operation the palato-pharyngeal sphincter mechanism is not competent. The aim then in repair of the palate is to produce a competent palato-pharyngeal sphincter

Unfortunately it is the experience of most surgeons to be presented with cases of cleft palate principally of the post alveolar type in which no operation has been carried out or in which such an operation has been unsuccessful. There is no limit to the age at which surgical treatment can be undertaken but it must be realized that although a

successful anatomical and physiological result may be obtained there may be little or no improvement in speech Such cases must inevitably be submitted to a course of training The prognosis will depend on the ambition intelligence and auditory acuity of the patient A further factor of importance is the type of speech which has already been developed If articulatory bad habits are established these must be corrected and success will depend on the patient s ability to do this Where there are no articulatory bad habits it is possible to promise in most cases excellent speech results with little or no training *

Age at operation.—A. Pre-alveolar clefts.—The simpler types of hare-lip can well be left until the child has a good hold upon life or until the end of the first year This is not always popular with the mother but is I think safer for the child Moreover in the interval growth has taken place and it is easier to obtain a good cosmetic result Where the split extends into the nostril with consequent flattening and perhaps deviation of the septum earlier operation is indicated to allow that natural moulding of the skull which inevitably follows

B **Alveolar clefts.**—It is important to treat the alveolar clefts as soon as possible after birth as it is in this stage of life that the maximum effect is obtained from the pull of soft tissues It has been my practice in these cases to operate if the condition of the child permits at the age of about three weeks There is much to be said for those who advocate operation within a few days of birth since at this time the child is able to withstand trauma in a remarkable way The operation should consist of repair of the lip and nostril together with the formation of a floor to the nose. This can only be carried out if at the same time the cleft in the hard palate is repaired Where the cleft is bilateral the repair should be in stages—that is to say one side should be repaired the muco-periosteum of the hard palate being attached to a rotated flap of vomerine mucosa The opposite side is done a month or two later Secondary correction of the lip is nearly always necessary but early operation has the advantage of causing rapid remodelling of the skull and as has already been stated leaves little more than a cleft of the soft palate to be dealt with subsequently say at the age of a year

C **Post-alveolar clefts.**—This type of cleft is important principally because of the associated defect in the speech mechanism and on this account operation should be advised before speech with its usual defects becomes established. Children vary immensely in the age at which they begin to speak so it is not possible to lay down hard and fast rules and each case must be judged on its merits but in general it can be said, operation should be carried out before about the twentieth month The only reason for counselling delay is that the longer operation is deferred the less is the likelihood of deformity of the upper jaw and irregularities in dentition with the subsequent need for orthodontic treatment

Pre-operative preparation —First of all the child must be in good health and free from chest complications colds and so forth It

should have gone through a period of gain in weight during the time immediately preceding operation Children with hare-lips and cleft palates are notoriously difficult to feed They are often unable to suck the breast or a bottle and are consequently at a considerable disadvantage, Each meal is a lengthy process which requires the greatest patience on the part of the mother or nurse It can to some extent be *hastened by feeding with a fountain-pen filler* a *teaspoon* or a *bottle* bearing a premature teat. The greatest of all virtues however is patience In infants the question of tonsils and adenoids does not arise but in older children *it is wise to make sure that there are no* gross septic foci about the mouth Minor degrees of sepsis do not seem to have much influence It is as well to have the child admitted to hospital 48 hours before operation. Fever and threatened infectious diseases can sometimes be noted in this period The child s normal feeds are continued until four hours before operation. One hour before operation the stomach may be washed out. Half an hour before the administration of the anæsthetic a hypodermic injection of 1/1 200 grain atropine is given This dose applies to any child below the age of three months.

Anæsthesia.—Anæsthesia is best carried out by an endotracheal tube. *The anæsthetic consists of oxygen and ether preferably without the use* of any re-breathing bag This method is described by Dr Philip Ayre.*

For purposes of description the repair of a complete unilateral or alveolar cleft will first be considered since the underlying principles are applicable to any type of hare-lip



Fig 775 —Where the cleft is complete, the hard palate should be repaired as shown above at the same time as the lip operation.
(Reproduced by permission from Diseases of the palate by Victor Veau.)

OPERATION FOR COMPLETE UNILATERAL OR ALVEOLAR CLEFT

Repair of the hard palate and ***floor of the nose.***—The operation is carried out under endotracheal anæsthesia. The pharynx is lightly packed with gauze to avoid aspiration of blood The jaws are held open by a mastoid retractor Starting at the level of the maxillary tuberosity an incision is made along the outer side of the hard palate close to the alveolar margin and passes forwards into the anterior edge of the cleft The muco-periosteum

* *Brit. Journ. Surg.*, 1937-8, xxv No. 97 131

is then split along the free edge of the cleft as far back as the posterior edge of the bony hard palate Using a small elevator the whole of the hard palate is raised from its bed but it is left attached to its blood supply from the posterior palatine artery The flap is dissected up until the posterior edge of the bony palate is reached An incision is then made along the full length of the nasal septum at the point of its attachment to the palatal process of the opposite side An elevator is inserted into this incision and a flap of mucosa is freely dissected up from the septum. This flap is then displaced laterally and the previously separated flap of hard palate tissue is sutured to it by two or three fine catgut sutures (8/0 chromicized) These are passed in such a way as to obtain the broadest possible contact between the raw surfaces The mucous membrane of the lateral nasal wall is stripped up and sutured to the anterior end of the septal flap which had previously been separated In this way a determined attempt is made to form a floor to the nostril. The suture material is 8/0 chromicized catgut and the sutures should be passed preferably as end-on mattress stitches (Fig 775)



Fig 776 —The shaded area shows the degree of subcutaneous separation necessary before attempting to unite the lip.

Repair of the nostril and the lip.—Most of those who are practising hare-lip surgery are indebted to Blair and Brown* for many excellent ideas and these authors in turn pay tribute to the operation devised by Mirault No attempt will therefore be made to describe this operation but a compromise based upon it and which has proved eminently workable will be described

Firstly it must be recognized that in order to produce a good lip and nostril it is essential to free the suture line from all tension This can only be done if the soft structures are thoroughly freed from the underlying bone Kinking of the nostril on the cleft side is inevitable if the alar cartilage is not freed from the nasal process of the superior maxilla and also from its overlying skin Repair of the nostril and lip are started by continuing forwards the incisions used in repair of the floor of the nose These incisions are carried around the anterior end of the maxilla and premaxilla respectively and are continued far along

* Surg Gyn. Obst 1930, II, 81

the gingivo-labial sulcus Through the gap thus made the soft tissues of the cheek and nostrils are raised from the underlying bone. Fig 776 gives an idea of the extent to which this is carried out Through the same incision the points of a pair of fine curved scissors are inserted



Fig 777 —Sharp-pointed scissors are inserted between the alar cartilage and its over lying skin.



Fig 778 —The incisions in the lip are outlined. It will be noted that the incision on the side of the cleft is curved, while that on the opposite side runs close to the red margin.

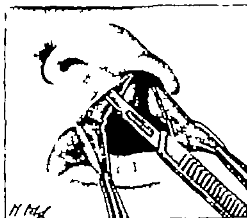


Fig. 779.—The flaps have been cut and the skin is being separated from the underlying muscle.

and are passed between the alar cartilage and its overlying skin the points being widely opened and effecting blunt dissection in the tissues between these structures (Fig 777)

The next stage consists in the preparation of the lip-flaps These must be cut in such a way that the two surfaces to be opposed shall be equal in length This can be assured by plotting out the incision with a fine pen dipped in indigo-carmine or other dye or by means of callipers As will shortly be seen the incision in the outer or cleft side of the lip is curved and consequently callipers will not provide an

accurate means of measurement Much description can be saved by reference to Fig 778 which is modified from Blair and Brown s paper The incisions commencing above are carried through the whole thickness of the lip and terminate at the red margin The incision on the side opposite to the cleft passes to the outer limit of the philtrum The two flaps thus freed are left attached to be dealt with later The skin of both prepared lip-edges is now undermined either by a sharp knife or fine sharp scissors in order to detach the underlying muscle and prevent infolding or depression of the suture-line by this means it is also possible to obtain more accurate and secure suture of the underlying muscle which is after all the factor of greatest importance in the repair of the lip (Fig 779) With this last step everything is ready for suturing First of all the alar cartilage is brought into its correct relationship with the columella, and a stitch of fine plain catgut is inserted but not tied at this point. Once this relationship has been accurately obtained by comparison with the opposite side the floor of the nostril proximal to this point is sutured with 6/0 plain catgut on this occasion the sutures being tied The first suture to be inserted



Fig. 780 —End-on mattress sutures embracing the muscle and mucous membrane of the lip
Note that the sutures are tied from inside the mouth.

remains untied because it makes accurate apposition of the muscle possible Altogether three sutures of 6/0 plain catgut are used to unite the muscle of the lip Plain or unchromicized catgut is well tolerated by the tissues of the lip the use of buried chromicized catgut is often followed by troublesome sinuses which ruin the appearance of the suture-line The sutures are passed from the inside in the form of end-on mattress stitches (Fig 780) The first to be inserted picks up the muscle close to the alar cartilage and immediately beneath the suture first inserted to gain apposition This is tied at once This stitch is extremely important because it affords the principal support to the nostril and helps to maintain its shape. The second suture picks up the muscle in the middle of the lip and is once again tied on the inside The third is applied near the level of the junction of the red margin and the skin and is left untied till the flaps of red margin have been shaped

Fashioning the red margin can be done in one of two ways Firstly the previously prepared flaps can be cut off by an incision which passes obliquely from the margin leaving an excess of tissue to allow for subsequent contracture (Fig 781 A) or the red margin flaps may be fashioned according to the method described by Veau and by Blair

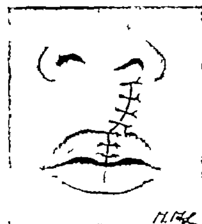


Fig 781A.—One method of closure, showing some redundance at the vermilion border to allow for contraction.

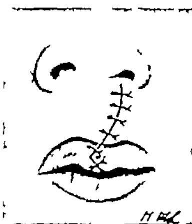


Fig 781B.—The red margin flap on one side of the lip is larger than that on the other side It is pointed to fit into a previously prepared area of the opposite side

and Brown really a modification of the operation of Mirault. (Fig 781 B) Whichever technique is chosen (the latter is undoubtedly the better) it is extremely important to get accurate apposition of the cleft at the point where the red margin joins the skin. Skin sutures consisting of gossamer silkworm gut mounted on eyeless needles are now inserted They should be introduced close together and close to the skin edge and lightly tied.

Flattening of the nostril in spite of free separation from bone and from skin may still be troublesome. Some help can be obtained however by refixing the alar cartilage to its overlying skin by two or three fine mattress silkworm sutures passed through the full thickness of the nostril as in Fig 782 Further help can be obtained by the insertion of a rubber tube sufficiently large to fill the nostril. This can be retained for a week being removed only for cleaning

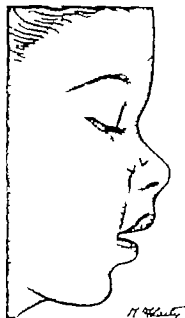


Fig. 782.—Mattress sutures passed through the full thickness of the ala sometimes prevent kinking.

After-treatment.—The operation is completed by applying a Logan s bow (Fig 783 A) which consists of a malleable metal support with hooks which are used to affix pieces of adhesive plaster After the bow is applied its free ends are lightly squeezed together so as to remove the tension from the suture-line The suture-line should be smeared with petroleum jelly and left exposed to the air but the greatest care is taken to avoid the

formation of crusts Crusts are gently mopped away using fine pledgets of wool moistened with a little weak hydrogen peroxide solution held by fine dissecting forceps This may have to be done every few hours to secure the best possible scar The suture-line is inspected after 48 hours and any sutures which appear to be tight or

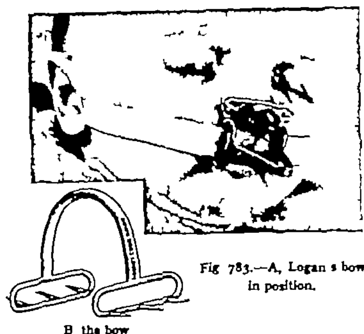


Fig 783.—A, Logan s bow in position.

B the bow

any which appear to have tightened up with œdema are cut but not removed until 48 hours later The sutures should be taken out on the fourth day without removing the Logan s bow which is left in position for a full week (Fig 788)

Operation for Bilateral Alveolar Clefts

Bilateral alveolar clefts offer exactly the same problems in treatment as do the unilateral clefts The problem is however complicated by two features of considerable importance Firstly the premaxilla shows a wide variation in anatomical form It may be mounted firmly on the end of a very stout buttress of vomerine bone and moreover is often tilted upwards or even to one or other side but in nearly every case it projects prominently forwards and often beyond the tip of the nose Excision of the premaxilla or removal or division of the vomer must be assiduously avoided since this bone represents a firm base upon which to reconstruct the muscle of the lip and consequently to remodel the whole skull. Proof of this can be seen in the fact that within a few weeks of the attachment of one or both sides of the lip the premaxilla has altered its relationship to the upper jaws and consequently to the whole face Fig 778A shows the result of removal of the premaxilla the gross retroposition of the lip producing a most unsightly deformity Secondly the prolabium that is the isolated portion of the lip overlying the premaxilla varies very greatly in size and in

thickness so that whereas in some cases it can be used in its entirety to fill in the gap in the lip in other cases it is almost useless If it be remembered however that the primary object in the closure of the lip is to obtain the pull of the muscles of the face then the prolabium can be seen to offer a very important anchorage



Fig 784.—A, alveolar cleft before operation. B same case at the age of two years. Some secondary correction of the lip margin is needed.

Bilateral complete clefts are best dealt with in stages and since it is necessary to repair the hard palate and utilize vomerine mucosa on both sides the prolongation of the operation and increased risk of sloughing due to wide separation of soft parts from bone are often more than little children can be expected to endure Therefore the lip on the wider side of the cleft is repaired first exactly in the same



Fig 785.—A, bilateral alveolar cleft. B, left side of the cleft repaired. C, same case after repair of both sides. Secondary correction both of the lip and floor of the nostril is required.

way as described for the unilateral cleft with the difference of course that in cases where there is but little prolabium it is not possible to obtain a complete attachment for the muscle of the lip and one is

bound therefore to be content to make as good a job as possible of the nostril and floor of the nose leaving the complete reconstruction of the oral sphincter to a subsequent operation (Figs 784 785)

Operation for Post alveolar and Partially Repaired Alveolar Clefts

The object of operating upon a post alveolar cleft is to obtain a functional result that is functional in so far as speech and deglutition are concerned Normal speech depends upon the ability of the speaker to separate the oral and nasal cavities by means of the palato-pharyngeal sphincter mechanism In the unrepaired cleft of the palate this is of course impossible It is also impossible to attain this object by means of many of the operations at present practised and the reason lies in the fact that in cleft palate the whole of the naso-pharyngeal diameters are markedly increased and in addition the palate is shortened and unable to reach the pharyngeal wall. The basic fault lies in the skull supporting these soft tissues Before therefore normal speech can be restored it is necessary to reconstruct a functional palato-pharyngeal valve and this is all that surgery can do

The names attached to operations for cleft palate are legion— which merely demonstrates the difficulties

The **Langenbeck-Fergusson operation,** on account of its simplicity has had many advocates. It consists of simple suture of the cleft in the midline lateral incisions being made close to the alveolar margin to allow thorough mobilization The primary fault in this operation is that no account is taken of the increased naso-pharyngeal diameters or of the paucity of the soft tissues. Moreover as pointed out by Veau the united flaps are left with a raw upper surface which is open to infection and worse still to subsequent scar contracture The speech results have never justified faith in the anatomical imperfections of the operation which should be abandoned completely

The **Veau operation** represented a new departure in that he advocated the obliteration of all raw areas and the reconstruction of the palato-pharyngeal valve by suture of part of the component muscle The first object was attained by using the mucous membrane on the nasal surface of the hard palate and the mucosa covering the vomer and by designing the flaps in such a way that they lay snugly against the bone from which they had been separated Reconstruction of the palato-pharyngeal sphincter he hoped to obtain by the insertion of a phosphor bronze suture embracing the muscle of the soft palate on each side Veau ignored the increased diameters of the naso-pharynx and the underlying altered architecture of the skull His published results have marked a new era in cleft palate surgery and our present knowledge of the subject owes much to his work Many of his methods are embodied in the operations described below

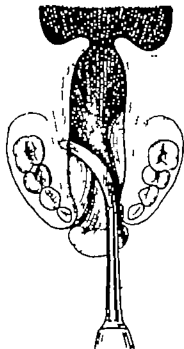


Fig. 786—Langenbeck Fergusson operation Separation commenced from the cleft on the left side.

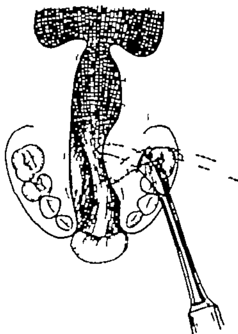


Fig 787—Separation from a puncture on the right side.

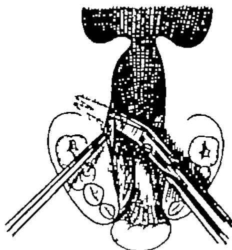


Fig 788—Detachment of the aponeurosis of the soft palate from back of bony palate with the scissors used at a right angle.



Fig 789—Narrowing of the cleft and elongation of the palate after thorough separation of the right side, in contrast to the left side which is not yet touched.

Dorrance advocates an operation known as the push back which is done in two stages and is apparently applicable only to those cases where the cleft involves the hard palate to a limited extent Dorrance hoped by this means to push the palate back to the pharyngeal wall and thus form an effective sphincter As yet he has not published his detailed results

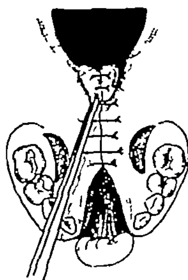


Fig. 790 —Small lateral incisions have been made. The sutures have all been tied and the uvula is turned upside down to show its upper surface drawn together with two points of fine chromicized catgut.

The recommended operation * — The operation I have found most satisfactory does reconstruct functionally the palato-pharyngeal sphincter mechanism It consists of two parts firstly pharyngoplasty and secondly repair of the palate Pharyngoplasty was designed by myself to reduce the increased diameters of the naso-pharynx by means of a transverse incision through the posterior pharyngeal wall this being resutured in a vertical direction. The repair of the palate is the result of a gradual process of development in which much of the work of Veau is incorporated and in which many of the ideas of the present day are brought into practical use.

The operation has the following advantages Firstly it enables a complete closure to be obtained at one sitting secondly with slight modifications it is applicable to all types of cleft thirdly the V Y advancement obtained secures the greatest possible length of velum without any artificial juggling with the uvula or pillars of the fauces and fourthly it is quite definite that if the principles of the operation as described below are practised on infants below the speech age i.e before about two years and a successful closure is obtained the majority of these children will learn to speak naturally without any speech training and will be indistinguishable from normal children (*See* p 1942 on speech results)

Technique of the operation.—There are four principal stages (1) preparation for the pharyngoplasty (2) preparation of the palatal flaps and freeing from bony structures (3) completion of the pharyngoplasty and (4) suture of the flaps

The head is thrown well back over a low pillow or over the end of the table Illumination is of great importance the best being given by a shadowless light although a headlight or even a single powerful bulb situated in the right position will *sometimes* do A transverse incision is made through the mucosa and the superficial fibres of the superior constrictor muscle of the pharynx at the level where the ridge of Passavant normally forms during pharyngeal muscular

movement This level can be identified either by making the patient gag under light anæsthesia or by noting the situation of the anterior arch of the atlas which forms a cushion shortly below the level of the adenoid pad The incision is best made by a No 11 or 15 Bard Parker blade the hand being steadied by resting on the right cheek. Bleeding rarely gives any trouble and can be arrested by the pressure of small gauze swabs The lower edge of the incision is then picked up in long fine mouse-toothed dissecting forceps and a special elevator (really a short aneurysm needle) is introduced between the superior constrictor muscle and its enclosing buccopharyngeal fascia The point of the



Fig 791 —Transverse section of the pharynx in a case of cleft palate A, Anterior pillar of the fauces B Posterior pillar ; C, Salpingopharyngeal fold.

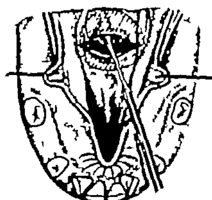


Fig 792.—Pharyngoplasty The elevator is introduced beneath the edge of the incision, and the mucosa and fibres of the superior constrictor are raised up. The shaded part indicates roughly the area of undermining The dark vertical lines indicate nicks which are sometimes made to increase the raw area available for suture.

Figs 791–810 are reproduced, by permission, from the *Brit. Journ. of Surg*

elevator is gradually worked downwards and from side to side until a considerable area is undermined and until its point passes beyond the salpingopharyngeal folds These are tight fibromuscular bands which lie on the lateral walls of the pharynx passing in a vertical direction from the bullæ of the Eustachian tubes and in their lower parts lying close behind the posterior pillars of the fauces (Fig 791) During the whole of this process some resistance should be felt to the movement of the elevator should there be no feeling of resistance then it usually means that the buccopharyngeal fascia has been perforated and the retropharyngeal connective space has been opened. Having dissected the lower part of the incision the upper part is now begun and the undermining is continued as far as the base of the skull At this point the elevator is removed and reinserted at the end of the transverse incision the salpingopharyngeal fold is picked up and the incision is continued into but not through the fold. This is repeated on the other side Sometimes when the denuded area so provided appears

insufficient a small vertical snip is made on the inner side of each salpingopharyngeal fold (Fig 792) to increase the raw area available for suturing

The process of suturing is now begun and as the object of this part of the operation is to produce a ridge on the pharyngeal wall and at the same time to narrow the naso-pharynx from side to side the incision is sutured transversely The most important point in this connection is to take a big bite of tissue containing the salpingopharyngeal fold the only really firm supporting structure in the posterior part of the naso-pharynx. For this purpose No 0 or 000 chromic catgut is used and is mounted on a ¾ in half-curved needle or on a large Reverdin

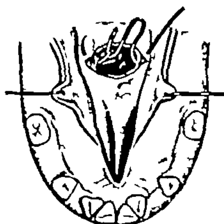


Fig. 793.—The needle is shown passing through the left salpingo-pharyngeal fold.

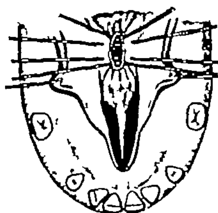


Fig 794.—The effect of traction upon the sutures and how they tend to narrow the nasopharynx, the salpingo-pharyngeal folds being dragged together

needle Suturing is commenced by picking up a large bite of tissue at the very end of the transverse incision and including the right salpingopharyngeal fold Where an ordinary curved needle is used it is held by a von Eiselberg or some such needle-holder It is very important to have a needle-holder with the correct curve and the von Eiselberg type has been found best for this purpose The left hand end of the incision is now picked up by the needle and a good bite of the salpingopharyngeal fold is once again taken (Fig 793) The catgut is left long and held by an artery forceps and is not tied until a later stage of the operation Altogether three or four sutures are inserted at least two of them gaining a good hold of the salpingopharyngeal folds the others being used to unite the cut edges of the central parts of the incision The operation when completed rarely looks neat but when the sutures are tied it is seen that there is a marked reduction in the diameters of the naso-pharynx* (Fig 794)

* There is a considerable body of opinion which regards pharyngoplasty as an unnecessary procedure. While willing to agree that this may be so in a proportion of the cases, I have never had the courage to abandon the operation completely because I had to learn cleft palate surgery the hard way

Preparation and freeing of the palatal flaps.—For the purposes of description it will be assumed that we are to deal with a cleft involving the soft palate and the hard palate as far forwards as the anterior palatine foramen

The hamular process is first identified by feeling for it with the index finger (Fig 795) An incision is then made on the outer side of this process and is carried along the hard palate closely hugging the alveolar margin and extending nearly as far as the anterior end of the cleft Then inserting an elevator into the posterior end of the incision the

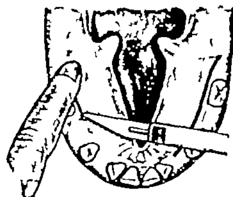


Fig 795.—The index finger of the left hand identifies the hamular process. The incision commences to its outer side

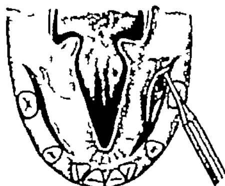


Fig 796 —The elevator is introduced into the incision and the hamular process broken off.

hamulus is identified and broken off (Fig 796) In some cases it may be necessary to use the points of a pair of strong scissors. The importance of division of the hamulus cannot be over-estimated since by its destruction the tendons of the tensores of the palate are released and one of the greatest obstacles to easy suturing and free mobility is removed A suitably shaped elevator is then passed into the lateral incision and the mucoperiosteum of the hard palate is raised along the whole length of the incision The elevator is then pushed inwards until its tip appears at the edge of the cleft The mucous membrane over the tip is either lacerated thereby or can be gently scraped through using preferably a sharp-pointed dental scaler This incision is carried round dividing the junction between the oral and nasal mucosæ along the whole extent of the hard palate cleft An oblique incision is now made on each side Each incision commences at the posterior end of the hard palate and at the border of the cleft and runs obliquely forwards and outwards (Fig 797) The mucoperiosteum of the hard palate is completely severed and of course at this point there is often free bleeding This procedure leaves four flaps two anterior and two posterior

The transversely oblique incision is made for a number of reasons. Firstly Veau pointed out that when the hard palate is left intact as

in the Langenbeck operation (or Axhausen s modification) the muco-periosteum is as it were left in mid air with a raw upper surface which must inevitably granulate and of course give rise to dense scar tissue Veau then devised his well known method for the formation of flaps based upon the posterior palatine arteries in which the upper raw surfaces were permitted to lie snugly against the bone from which they had been detached Personally I had never felt happy about the long Veau flaps which rely for their blood supply on a source which is liable to a good deal of trauma or even to kinking over the hard rim of the foramen through which it passes to reach the flaps This kinking must be exaggerated during the suturing and it has been my experience that in the widest types of cleft one of the principal factors preventing the flaps meeting in the midline is the intact posterior palatine arteries I am not convinced that pulling these vessels out of their bony canals can preserve a blood-supply adequate to allow any liberties. Consequently by a gradual process the oblique incision of Veau was brought farther and farther back until now it is commonly made from the posterior edge of the bony palate thus forming a very short posterior flap which allows deliberate division of the posterior palatine artery wherever necessary and without any more fear of destroying blood-supply than in a similar flap anywhere else in the body

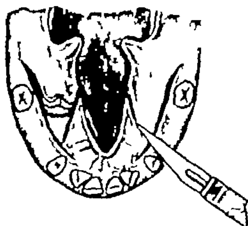


Fig 797 —The mucoperiosteum of the hard palate is completely severed by an oblique incision.

Starting on the left side the posterior flap is picked up either with a hook or with fine dissecting forceps and is raised from its bed. Using an elevator once again the flap is dissected up until the posterior free edge of the bone is reached The elevator is then inserted behind the posterior edge until the soft palate is completely freed from the bone and only remains attached by the mucous membrane on its nasal or upper surface The elevator is then introduced on the upper surface of the hard palate between the bone and its nasal mucosa and this again is carefully raised along its whole length. After this procedure the principal structure which remains fixing the soft parts of the palate to its bony parts will be the posterior palatine artery and its sheath and in many cases unless the artery be divided the palate cannot be sutured without tension. To deal with this the artery is gently pulled as far as possible out of its canal. A fine artery forceps is applied to the vessel close to the bone and it is cut through and twisted (Fig 798) This leaves the whole of the bony attachment of the soft palate exposed and the dissection is continued near the

base of the hamular process and the maxillary tuberosity and along the posterior border of the internal pterygoid plate until the whole of the palate is quite loose and almost falls back into the naso-pharynx (Fig 790) It is advisable to take care while carrying out this dissection that it is not continued too far along the internal pterygoid plate otherwise there is a risk of damage to the attachment of the Eustachian tube. If the separation is not felt to be free enough a finger pushed into the lateral incision will often sever the few remaining strands which are anchoring the palate Finger dissection is not by

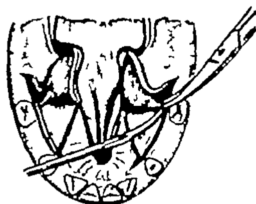


Fig 798 —When necessary the posterior palatine artery is seized, cut through and then twisted.

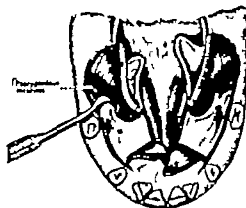


Fig 799 —The greatest care is taken to get free separation of the soft palate from the bony surface of the hard palate. Note position of the pterygoideus internus muscle and the fact that the nasal mucosa remains intact.

any means a new idea and the first surgeon I saw practising it was Professor Grey Turner

Now when the wound is opened up for inspection a large space will be found on the outer side into which the lateral incision opens It is bounded on the inner side by the palate and on the outer side by the tendon of the internal pterygoid muscle which is often plainly visible. This space may be freely opened, since it does not communicate with the deep fascial spaces of the neck and consequently any infection arising therein should not track into the mediastinum

The operation as described on the left side is now carried out on the right and, when both sides have been completed the halves of the palate often lie in contact with the pharyngeal wall and with one another

The next part of the operation consists of freshening the edges of the soft palate and the uvula preparatory to suturing This is done by excising a strip of mucous membrane by the usual method (Fig 800) but often a little extra freedom can be gained by making a small snip with the scissors in the soft tissues at the very front of the inner surface of the soft palate and close to the nasal surface (Fig 801)

Completion of the pharyngoplasty—This consists in tying the pharyngoplasty sutures which were inserted in *Stage* 1 This process is delayed until this stage because the raw edges of the incision now come together readily and without tension and at the same time they

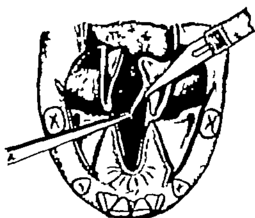


Fig 800 —The edges of the soft palate cleft are freshened by excision of a strip of mucosa.

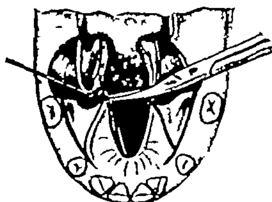


Fig 801 —A little extra freedom and thickness of palatal tissue will sometimes be obtained by making a small cut with the points of the scissors as indicated

drag with them the halves of the freed soft palate. Moreover the soft palate is now held in a position of considerable posterior displacement

Suture of the flaps —The process of repair begins in front by suturing

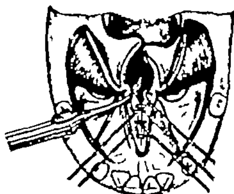


Fig 802 —The nasal mucosa is sutured according to the method of Veau. Note that two of the sutures have been left long to anchor the flaps.



Fig. 803.—Insertion of the sutures into what was formerly the mucoperiosteum of the hard palate.

the mucous membrane from the nasal surfaces of the hard palate (Fig 802.) These are joined together in the mid line using fine catgut mounted on a needle Several of the more anterior of these sutures are tied and left long being held by small artery forceps These are used later to anchor the flaps and prevent them from falling into the

mouth The suture of the nasal mucous membrane is carried along over the whole length of the soft palate and uvula. The oral surface of the soft palate is sutured with fine catgut inserted in the fashion

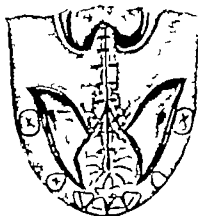


Fig 804. — Completion of the suture line.

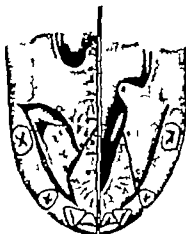


Fig. 805 —Illustrates diagrammatically how by cutting flaps in the method described a form of V Y advancement of the velum takes place. The letters indicate corresponding positions before and after operation.

of the end-on mattress stitch One or two of the more posterior ones take large bites of tissue and are tied lightly There is no need for tight suturing because everything is so loose that suturing can be carried out without tension

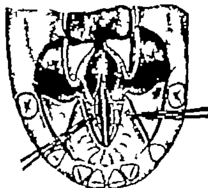


Fig 806 —The mucosa from the nasal surface of the hard palate is united to the vomerine mucosa. The situation of the stay sutures is shown.

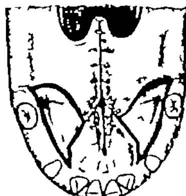


Fig 807 —Repair completed. The dotted line shows the approximate situation of the united nasal mucosa.

As soon as the soft palate is completely repaired on nasal and oral surfaces *attention is directed to the two anterior flaps* which are raised from the underlying bone and united by two or three end-on mattress stitches Next the cut edges of the muco-periosteum of the

hard palate (i e the edges of the posterior flaps) are united in a similar way (Fig 808) and it is found that in order to make the anterior and posterior sets of flaps meet at all the suturing must be continued some distance along the posterior edge of the oblique incision (Fig 804) Thus it is easily seen as shown in Fig 805 that considerable backward displacement of the soft palate has been effected and in fact a form of V Y advancement carried out In addition to this there is a small gain in the fact that both anterior and posterior sets of flaps are subjected to internal rotation

When the two sets of flaps are able to meet the catgut sutures which were used to unite the nasal mucosa and which were left long are mounted on a needle and passed through both sets (Fig 806) These act as stay sutures and prevent the flaps from falling from their bed into the mouth Two stay sutures only are required as a rule



Fig 808 —The vomer is attached to one side of the hard palate Its mucosa can be stripped as shown and used to form a floor to the nose

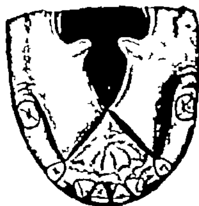


Fig 809.—Line of incision for a soft palate cleft.

and it is as well in passing them to arrange if possible that the suture line in the palate does not directly overlie that in the nasal mucosa as by this means there is less liability to the development of holes

This completes the repair of the palate. The lateral spaces heal up quickly without giving trouble and in any case such scarring as follows does not interfere with mobility of the soft palate since it overlies immobile structures

The method just described applies to that type of case where the vomer is not a prominent feature. Where the vomer is well developed much use can be made of its mucosa as shown in Figs 806 and 807 If the vomer is attached to one or other half of the hard palate as a unilateral cleft its mucosa is used as in Fig 808 In clefts involving the soft palate only the same principles should be applied as shown in Figs 809 and 810

After treatment need not be elaborate in fact the less local interference after operation the better but antibiotics should certainly be administered. Food should consist principally of milk and slops and

each feed should be followed by a drink of sterile water Custards and particularly jellies are gratefully accepted Where catgut has been used throughout there is no need to remove sutures Solid food can be taken after three weeks Children should be allowed out of bed as soon as the general condition permits. The elbows should be fixed in extension in light cardboard splints to prevent finger interference in the mouth

All cases should be carefully followed up and any irregularities in teeth or the development of the jaws should be submitted to an orthodontist Early defects in speech are common and usually require no treatment but in recent times the skill of the speech therapists has advanced immeasurably and their experience and sagacity must not be treated lightly *

Results.—After successful operation before the age of two to three years by the method described the majority of children will grow up

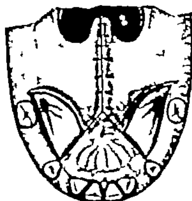


Fig 810 —Repair completed. Note degree of advancement.

as natural and normal speakers and require no speech training Speech training is only necessary in failed cases and where operation has been unduly delayed.

If it is remembered that the aim of repair of the cleft palate is to restore a functional oronasal sphincter then the results of a series of 100 consecutive cases operated by the above method and reported by Bentley and Watkins† are worthy of consideration Ninety cases were traced of these 46 spoke without any defect whatever 26 spoke perfectly but for minor defects due to irregularities of the lip and hard palate of the remaining 18 only 2 had incompetent oropharyngeal sphincters. They found little difference between the cases submitted to pharyngoplasty and those in which this operation was omitted.

Holes in the suture-line should not be hastily interfered with as they show a marked tendency to close spontaneously Particularly does this apply to holes in the hard palate which can if necessary

* See Muriel E. Morley Cleft Palate and Speech, Livingstone, 1954
† Bentley and Watkins, *Lancet*, Dec. 13, 1947 p. 862.

and after the lapse of months be closed by an obturator In the early stages of treatment of a small hole weekly applications of silver nitrate fused on a probe may be of great value.

Parents ask what are the prospects —

(*a*) Cosmetically Frequently a hare lip whether unilateral or bilateral pre-alveolar or alveolar does at some time need secondary

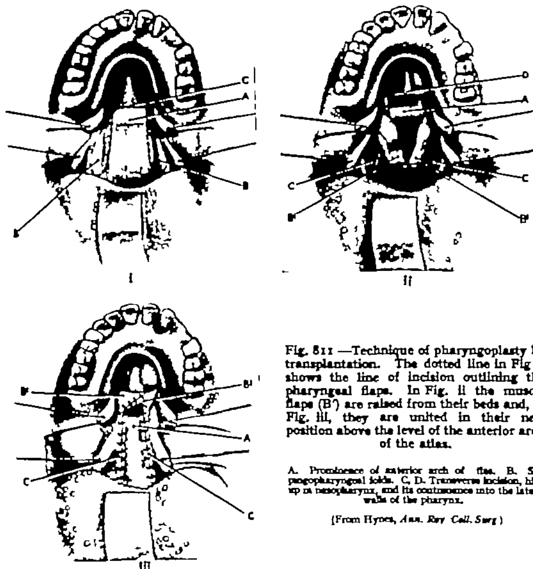


Fig. 811 —Technique of pharyngoplasty by transplantation. The dotted line in Fig I shows the line of incision outlining the pharyngeal flaps. In Fig. II the muscle flaps (B') are raised from their beds and, in Fig. III, they are united in their new position above the level of the anterior arch of the atlas.

A. Prominence of anterior arch of atlas. B. Salpingopharyngeal folds. C, D. Transverse incision, high up in nasopharynx, and its continuance into the lateral walls of the pharynx.

(From Hynes, *Ann. Roy Coll. Surg.*)

correction and it is therefore always wise to warn the parents of this and never to promise success at a first operation

(*b*) Speech Assuming a successful surgical result is completed before the usual age of speech development (that is two to three years) the majority of children with cleft palate will grow up without any cleft palate stigma with no speech training

Neglected and failed cases.—It falls to the lot of every surgeon who practises cleft palate surgery that very commonly neglected and

failed cases present themselves for treatment and offer problems which may well tax the ingenuity and skill of those who undertake them. The neglected cases very often show underdevelopment of the upper jaw and enormous increase in the size of the defect an unduly capacious naso-pharynx and the further complication of gross faults in speech The failures i.e those cases where previous and unsuccessful operations have been done present the additional difficulty of loss of tissue and very often dense scarring In the failures much can be done by the bold excision of scar tissue but neither in this group nor in the neglected cases can it be reasonably expected that a competent valve mechanism will be produced, without an associated pharyngoplasty For dealing with these cases Mr W Hynes of Sheffield has devised a new operation which certainly in his hands and also in my limited experience has shown great promise. The operation is based on the observation made by myself and Whillis* that during naso-pharyngeal closure the first muscle to contract is the salpingopharyngeus Hynes therefore dissects flaps of this muscle on each side and sutures them together above the level of the ridge of Passavant i e above the level of the anterior arch of the atlas in a manner which is best explained in the accompanying diagrams (Fig 811) By this means he obtains an actively contractile ridge and at the same time great reduction in the diameters of the naso-pharynx The operation is done as a preliminary stage the palate being repaired after an interval and preferably by the V Y method as described in this article. Sometimes closure of the hard palate is impossible and it of necessity must be abandoned to its fate the resulting defect being closed by an obturator

Failed and neglected cases are well worthy of surgical aid since it is surprising how often with the assistance of a skilled speech therapist intelligible or even perfect speech can be obtained

In conclusion it must be said that although there have been great changes in our knowledge of cleft palate and hare-lip there still remains a great field for further investigation Even with the methods at our disposal at the present time the results of treatment are more than gratifying

* W E. M. Wardill and James Whillis, *Surg. G[illegible] Obst* May [illegible], [illegible]

CHAPTER XXXV

PLASTIC SURGERY

By Sir HAROLD GILLIES and JOHN BARRON

Introductory.—Plastic surgery of to-day began in a war stage and then passed to a civil stage. Methods proved efficient by trial in the years 1915–21 were adapted and modified to civil conditions. Very substantial progress can be traced to this period. The outbreak of the 1939–45 War found a very augmented body of surgeons trained to do this work. As many as sixteen plastic units were staffed in this country and six Army units and a large number of burn units in the R.A.F. were developed. The establishment of the National Health Service finds scope for continuation of the war time units. A very great improvement in the technique of free grafting, both of skin and of bone and cartilage, occurred in this war. The treatment of the burn patient, both from a general and from a local point of view, has been one of the marked features of these latter years. The value of the principles of plastic surgery as applied to injuries and burns of the hands and injuries of the trunk and limbs with large losses of tissue has marked a step forward in the rehabilitation of injured patients by clean surgery. In regard to the development of cancer surgery of the face and body, a very strong urge exists among the group of plastic surgeons to rehabilitate the cancer patient at the time of the destruction of the cancer. Wherever this is possible it is thought to be desirable and to be the ideal of the future. The need for continued and extensive research in all branches of the work is still supreme.

Diagnosis.—In plastic cases diagnosis should be made with the greatest care and deliberation. The points to which particular attention must be paid fall under three headings:

1. Quantity of the lost tissues.
2. Character of the lost tissues, e.g. skin, mucosa, bone.
3. Shape of the lost tissues, in order that the shape and form of the portion to be transplanted may be accurately estimated.

Unless all these points are scrupulously attended to, mistakes in restoration will be very common.

It is also essential to make a decision on the *type of repair* best suited to the case in hand. This question is especially important when the plastic surgeon is called in to make good the loss occasioned by the removal of tissue by operations for malignant growths. He must decide whether some simple advancement operation will meet the requirements of the case, or whether the repair must be of a secondary plastic nature, to be carried out later. Operations involving only

small areas of tissue about the lips or eyelids more especially in old or infirm patients lend themselves to the simple procedures while in younger healthier patients and where the loss of tissue is more extensive the first operation should be carried out in such a way as to give the best possible ground on which to perform the secondary plastic restoration

Record-taking —*Plaster casts* and moulds may be of considerable help in assessing any loss of contour and the exact shape of any missing tissue Particularly is this preliminary estimation desirable when cancer removals are projected. Co-operation between the general and the plastic surgeons should be a normal routine of good surgery

Photographs —Photographs constitute the best form of record. Apart from their purely scientific value as recording the progress of the case they have a very definite psychical effect upon both surgeon and patient Such photographs must not be retouched if they are to be of any real value though it must be admitted that even so they fail to give precise records of all conditions.

Diagrams —Stamp diagrams of the face and of the palate can be purchased and on them the position of the small scars and many defects of the nose and lips can be adequately recorded A tape measure should be on the consultant s desk and the size of defects should be measured as far as possible In insurance compensation cases for instance stress is placed by the legal profession on the length of the scar

X rays —Radiography is of course used extensively where the loss affects skeletal tissues and in the demonstration of foreign bodies including glass

General principles.—The restoration of parts of the body destroyed or deformed as the result of congenital defect trauma surgical removal or disease should have for its main object restoration of function Concomitantly with this it should be the aim of the surgeon to secure a good cosmetic result

In all cases the principle of restoration in kind—bone for bone skin for skin—is of the greatest importance. The nearer the new approximates the old, the better the repair In this connection it is necessary to emphasize the utter futility of providing covering without lining whenever the loss extends into the nose or mouth or other cavity lined with mucous membrane.

Whenever such a wound is produced by trauma or by surgical operation and when a simple advancement operation to meet the requirements of the case cannot be planned and executed at the time of the operation it is best to suture skin to mucous membrane round the margin of the defect This ensures the minimum of deformity and displacement renders the skin round the defect available for turning in to form the lining required (thus doing away with the necessity for lined flaps) and in addition renders the operation a clean healing one

unlikely to be followed by secondary hæmorrhage Extensive application of this principle in the emergency treatment of a great variety of wounds of the face has proved its value in the prevention of cicatricial deformity and the simplification of ultimate repair Raw surfaces should be absent or reduced to the absolute minimum in all plastic procedures.

Planning an operation.—Every effort should be made to form a definite plan of repair especially in the larger types of defect It may be wise to give an example It is by no means impossible to give a plan for another surgeon to carry out a specified repair but minor and quite often major variations in the plan will always be found desirable and as the repair progresses these variations of the original plan require imagination and elasticity of thought.

In a typical case of loss of the skin of one cheek due to burns the first step would be to make an accurate measurement of the whole of the area to be replaced Due allowance should be included in this estimate for the retraction or replacement of normal tissues into their normal position when all the scar tissue has been excised. It is quite easy to fail to realize the full extent of the loss Great help can be obtained by comparing the damaged cheek with the normal one A templet of the area is then cut in jaconet or stiff tinfoil these materials being sterilizable at the time of the operation. When the donor site has been determined the templet is placed on it and the skin marked by pricks with a needle dipped in Bonney s blue to delineate the flap Several pricks may be made on the graft itself as identification points It is then necessary to make a decision whether the repair should be a free graft of skin or a flap There can be no doubt that a good flap to a whole cheek is far superior in cosmetic effect to any free graft Therefore the decision will be flap unless some factor such as age or time indicates the shorter but inferior procedure

The site of the donor area may then be chosen In the male a flap may be raised from the anterior pectoral region. This is tubed in type and is carried on an acromial pedicle—an *acromio-pectoral flap* In the female the lateral abdominal wall is more satisfactory as a donor site the flap in this instance may be direct and not tubed The pattern is then laid on the donor site to ensure that there is sufficient skin available. It is well to allow for cutting the flap very slightly on the liberal side to allow final excision of its margins.

The time factor must be fully explained to the patient and is the chief disadvantage of these repairs The shortest time in which the flaps may be transported is shown in the following tables Any attempt to hustle leads inevitably to eventual delay or disappointment No allowance has been made on these tables for the final review and possible trimming of the flap This must vary according to the circumstances of the individual patient. As a general rule the flap should be reviewed three months after the last operation but no harm (and often good) is done if flaps are allowed to settle for a year before

any minor trimming of the joining scars and edges or thinning is undertaken This final operation can usually be performed under local anæsthesia and the period of hospitalization is short

TABLE I —TIME FACTOR ACROMIO PECTORAL FLAP TO CHEEK

	Procedure	*Anæsthesia*	*Interval*	*Total time*
Operation 1	Pedicle and flap raised as a strap outer part tubed inner part re-sutured	Local or general	2 weeks	
Operation 1A	Outline of flap completely raised and re-sutured a delaying operation	Local	1 week	3 weeks
Operation 2	Transfer to face	General	2 weeks	5 weeks
Operation 3	Pedicle cut and plastic completed Donor area grafted	General	2 weeks	7 weeks

TABLE II —TIME FACTOR ABDOMINAL FLAP TO CHEEK

	Procedure	*Anæsthesia*	*Interval*	*Total time*
Operation 1	Outer half of flap raised and attached to prepared area on back of opposite wrist i e right abdomen and right wrist to left cheek Raw area abdomen grafted	General or local	2 weeks	
Operation 2	Inner half of flap raised but not cut across Re-sutured	General or local	1 week	
Operation 2A	Delay operation Incise three-quarters of inner border	Local	3 days	
Operation 3	Transfer of flap to upper part of face	General	2 weeks	
Operation 3A	Raise two-thirds of flap from wrist, attach and re-suture	General or local	3 days	
Operation 4	Complete division of flap from arm bed into lower face Suture wrist wound Graft raw area on abdomen		2 weeks	8 weeks*

* A shortening of time factor is confidently anticipated by the use of the tropine test (Hynes) and the radio-active sodium test (Barron)

Incisions.—All incisions should be made cleanly and with a sharp knife There appears to be no real advantage in any method of incision other than that in which the knife passes in a vertical direction through the skin.

Tissue trauma.—This must be reduced to the minimum and to this end very fine-toothed forceps or better still fine tissue hooks should be used for holding the skin edges Flaps of poor vitality are best held and manipulated in swabs moistened with warm saline

Hæmostasis.—In this matter the surgeon is constantly in a dilemma between the length of time occupied in ligating every vessel however

small and the amount of foreign material necessarily buried in the process on the one hand and the risk of formation of a hæmatoma—the worst enemy of the blood supply of a flap—on the other

Very fine catgut or fine silk which allows even smaller knots may be used where necessary but direct crushing of vessels without ligature is used wherever possible A refinement of technique is the production of a fibrin clot by introducing thrombin and fibrinogen under flaps when suturing is complete Whatever method is used the perfection of a pressure dressing technique is a *sine qua non* of all plastic procedures When induced hypotension is being applied for ease in operating even greater care must be exercised in order to ensure complete hæmostasis The hæmatoma and extravasation which can occur in the immediate post-operative phase when the blood pressure rises can destroy the most perfectly planned and executed repair

Deep sutures.—Here again the introduction of more foreign material than is absolutely necessary must be strictly guarded against.

Deep catgut sutures may be required in order to obliterate dead spaces and to diminish the tension on skin-edges the muscle and/or fat are united by sutures placed at right angles to the line of incision their knots preferably being placed on the deep aspect The actual skin when tension is an important factor can best be approximated by the mattress type of catgut suture placed parallel with the skin edges and taking up the deep part of the dermis Occasionally deep stitches should take their purchase from fixed points if practicable beyond the area of the flap as for example from malar bone to cheek beneath a flap in this region The edges of the flap are thus relieved of all strain on skin sutures For these deep sutures very fine 4/0 catgut may be used on an eyeless needle In neck wounds great care should be taken to mobilize and suture the platysma in this manner

Skin-sutures.—For suturing the skin a fine cutting needle of a shape suiting the surgeon s preference should be used The abdominal eyeless catgut needle has been modified suitably for skin-suture and anyone who has once used an eyeless needle in the skin will never be content to go back to the older method.

Many varieties of stitch are used the simple interrupted and the over and-over continuous type most frequently Fine silkworm-gut is suitable for sutures upon which little strain is expected. The continuous lock or blanket stitch gives nice eversion of skin-edges and is particularly useful when the surgeon is working single-handed. Where there is much tendency to infolding of the skin margins the end-on mattress suture either interrupted or continuous is the most satisfactory Mention should also be made of the triangular stitch for suturing three points with one stitch the centre point being picked up subcuticularly

Though the subcuticular stitch has the great advantage of absence of external stitchmarks it is not found especially suitable except in the straighter incisions where scar tissue is absent and there is no disparity

TABLE III —FREE GRAFTS

Type		Donor Area	Recipient Area	Method
Split skin grafts	Thin	These grafts are usually taken from the inner side of the arm where it is hairless	Used mainly in places where mucous membrane is normally present e.g in the mouth (buccal inlay) intranasal grafts, contracted eye sockets, the urethra, the vagina	This is the true Thiersch graft Cut with Blair or Thiersch knife kept on the stretch during cutting by a greased board. Graft applied on a Stent mould with pressure
	Medium	Inner side of arm, abdomen, thigh, back, buttock	Used for covering granulating surfaces of all descriptions following burns and skin avulsions. Will take in the presence of minimal infection	Cut with Padgett or electric dermatome Blair or Humby knife. Applied in sheets, strips or patches. Pressure dressing of a mould of wool soaked in paraffin flavine emulsion
	Thick	As above	Defects created surgically	As above
Dissected grafts whole thickness grafts Wolfe s)		The inner side of the arm, clavicular region, outer aspect of the thigh, the back of the ear and upper eyelid	Eyelids, and portions of the face in which a good cosmetic effect is specially worth attempting When successful, they are more flexible and of better texture than split-skin grafts	The skin is excised in anatomical dissection down to but not including the fat The graft is cut to such a size and shape that when it is sewn into its bed it will be at the tension of normal skin—in other words, an exact fit. Pressure applied *See* p 1952
Hair-bearing grafts These are also dissected grafts. Care must be taken to include all the hair follicles		The mastoid strip	Eyebrows and moustache	*See* pp. 1954 1957
Pinch grafts		The thigh	Clean granulating wounds where a cosmetic effect is not imperative	Rarely used
Chondro-cutaneous or composite grafts		The pinna	Replacement of defects of the alar margin or of the columella	A shaped graft including the skin

Mucous membrane grafts	The mucous membrane of the lower lip and inside of the cheek	Their uses are almost entirely [illegible] conjunctiva, when there is a normal eye present, and particularly in symblepharon to form the lining of new eyelids. They also may be used in the urethra	[illegible] sected but may be shaved with a tiny razor They are usually cut to the size of the part to be replaced and sewn in *Note* Even the thinnest skin graft is likely to grow sufficient hairs to irritate an eye
Fat grafts	Fat is usually obtained from the abdominal wall, and frequently from the area of an existing scar The more firm the type of fat the less will its bulk be absorbed on grafting	The commonest application of fat method is for building up the contour of the cheeks or chin or for insertion beneath a previously implanted skin graft They may also be used under depressed scars	A piece of fat is cut to the shape required and about 30 per cent larger than finally required to fill the defect to allow for shrinkage It is then inserted underneath the depression
Dermo-lipomatous	Abdomen	As for fat grafts A firmer graft which contracts less than the fat graft	A *thin split-skin graft is removed* and the underlying dermis and fat taken as a free transplant. The split-skin graft is returned to its original position
Cartilage grafts	(1) Seventh costal cartilage (2) Septal, alar *and conchal* cartilages. Preserved human cartilage Homologous maternal ear cartilage *Bovine cartilage*	Chiefly the bridge of the nose alar curve and contour of the pinna	*See* p 1957
Bone grafts	Usually the ilium Tibia Osteoperiosteal Medullary chips	Defects of the mandible Used for facial contours, particularly nasal Delayed union Chip cancellous grafts. An easy method of restoring contour defects with bone Used with cortical bone, internal splintage to encourage early callus in continuity defects of bone	*See* p 1958 Dissection The iliac crest is removed All cortical bone is cut off and the cancellous bone is cut into tiles average 1 cm. square × [illegible] cm thickness
	Osteochondral (rib)	For angle of jaw	See Gillies (19[illegible]0) Plastic Surgery of the Face O U P (p 181)
Fascia lata grafts	Lateral aspect of the thigh	These may be used as contour padding in the same way as fat or in the form of bands or	*See* p 1959

in length between the edges to be apposed It has however been much facilitated by the eyeless needle and has now taken the place of many of the above methods Greater care in placing the plane of the stitch at equal distances from the skin surface has by the excellence of the result greatly increased its popularity Either silkworm gut a prepared silk such as Deknatel or stainless wire may be threaded on an eyeless needle. The wire suture has become increasingly popular as it does not break holds the skin edges nicely together and is easily withdrawn Perhaps the best results are obtained by using two subcuticular stitches one for the deep and one for the superficial layers of skin. In connection with flap surgery mention may be made of the unilateral subcuticular stitch This has the advantage of the subcuticular suture which is less embarrassing to the flap margin where blood supply is often depleted and at the same time holds the edges of the wound in accurate apposition. It is in essence a horizontal mattress suture passing only through the dermis of the flap and is tied on the opposing skin surface It can be used as a continuous stitch even on curved or angulated incisions *

External dressing methods to obtain an even pull towards the incision so relieving skin tension are strongly recommended. Ordinary Z O plaster elastoplast and better in most situations lastonet fixed with mastisol are in common use and in addition enable some pressure to be applied over the wound itself

Drainage —Drainage should be provided whenever hæmostasis is incomplete

Skin-grafting —There are two main types of skin-graft the split skin graft and the whole thickness (Wolfe graft)

The split skin grafts are used in three thicknesses. The thin split skin graft (Thiersch graft) is reserved for the reconstruction of the mucous lining of the mouth nose conjunctiva urethra and vagina. The medium split-skin graft is commonly used for covering granulating surfaces in the treatment of burns and infected skin avulsions This graft is applied in sheets or is cut up into strips or patches It is often used in the presence of infection and the degree of infection determines the thickness and size of the graft to be used. The greater the infection the thinner the graft should be and where there is much exudate from the wound surface the graft is divided into strips or patches to facilitate drainage The thick split skin graft is used for the cover of sterile defects following large excisions of skin on any part of the body Contracture is less than with the thinner grafts and its ultimate texture is better depending upon the thickness of dermis which is taken with the graft

The whole thickness graft is reserved for special occasions and situations because of the greater difficulty of its application. When successful its advantages lie in the thickness and texture of the transplant

* Barron *et al* *Br J Plast Surg* 1953, 6, 177

Numerous methods of fixation are employed but all depend on the principle of pressure providing an intimate coaptation of the soil and the transplant By far the greatest revolution in skin grafting has arisen out of the pressure method of fixation This is seen in its most startling form in skin-grafting a pocket in the mouth or nose Esser deserves credit for his original idea of using a mould buried in the tissues but far more do the Sidcup surgeons and dental surgeons who made it by progressive modifications into one of the most certain operations in surgery Whenever possible an accurate mould of the raw area should be made and the graft placed on the mould. If more than one graft is required the pieces are so placed that their adjacent borders just overlap one another On convex surfaces pressure bandaging suffices

The moulding material most commonly used is Stent s—a piece of which is dropped into boiling water just before use It is applied to the area when cooling off and set thoroughly with cold sterile water When ready the mould may be fixed in position with strapping mastisol fixation or stitches across it Another common method is to use wool soaked in paraffin and flavine and to tie it over the graft by the long ends of the stitches

In the mouth various forms of dental splint are used to carry and retain the mould. Splints fixed to the teeth are similarly used in grafting the interior of the nose but suture to adjoining healthy skin or simple fixation by adhesive strapping is employed where no other means is available

The thin and medium split-skin grafts are cut with a razor or special knife and may be taken from any part of the body though as they must usually be hairless the regions commonly sought are the inner aspect of the upper arm and the anterior aspect of the forearm and the thigh The area chosen is cleaned with ether and immediately before cutting the graft is again washed over with the same antiseptic The area is shut off by sterile towels clipped round the limb the arm is held at right angles to the body by an assistant. An assistant applies a strip of wood on the arm at the upper extremity of the area while the operator manipulates another—the border of which is greased—in such a way as to lead the razor down the arm Variations of pressure with the board will determine the tension and area of skin presented to the cutter Some slight support from below with lateral stretching of the skin of the limb may also be required

Various substances such as sterile petroleum jelly and saline have been used to lubricate the knife and prevent rucking Bold cross strokes of the razor with even downward pressure are required for the actual cutting and the surgeon should aim at obtaining a graft of even thickness throughout

Much experience is required to cut a large thin graft

Thick split-skin grafts are now usually cut with a dermatome the calibrated instrument which allows of accurate skin splitting at a pre-determined thickness. The dermatome will cut large sheets of

skin of perfectly even thickness and is thus more accurate than the free-hand method

Once the graft is cut it is placed immediately upon the mould already made in Stent of the area to be grafted and is evenly spread over its surface with the raw surface outside. The mould with skin-graft is then replaced on the area to be grafted and fixed in position by the most convenient means available.

A practical method of manipulating skin-grafts especially if multiple grafts have to be fitted together is as follows —*Tulle gras* a wide-meshed greasy material of the size of the area to be covered is placed on a flat surface on the instrument table. Several pieces may be overlapped and smoothed together The grafts are now laid over this with their raw surfaces upwards in such a way as to cover the entire area. Each graft is overlapped slightly over its neighbour so that there are no gaps at the joins By lifting this piece of *tulle gras* carefully the whole can be carried in one piece to the wound It can then be sutured to the margin the ends of the stitches being left long

A mould is now made using fine sponge sorbo sponge wool soaked in flavine emulsion or Eusol soaked gauze This should fit the surface of the graft exactly The long ends of the stitches are tied over the mould which then distributes pressure to the graft from the overlying bandage or strapping fixation This pressure dressing must be very accurately applied

Wolfe's method.—A Wolfe graft is made from that portion of the skin which extends down to but not into the fatty layer It is cut by a small scalpel in much the same way as skin is raised in the dissecting room. The graft which has been marked out by pinpricks in Bonney s blue is cut of exactly the same size and shape as the area to be covered for it is essential that it should be provided with conditions of tension as nearly as possible like those it possessed in its natural position. It is placed on the area prepared for its reception and its margins are accurately sutured with fine stitches *close to the edge* preferably of the continuous type. Here it is especially necessary to bear in mind what has been said under the heading of tissue trauma (p 1948) for every smallest damage is likely to show as a spot of localized gangrene in the finished result A mould of the raw area is made in dental composition before the graft is sutured into place this when fixed by the pressure method given below effectually prevents any accumulation of blood or serum between the graft and its bed Here again is illustrated the principle of pressure-dressing

Pressure is applied for a varying length of time Ferris Smith aims at 80 mm. of mercury pressure for 12 days Although successful Wolfe grants have frequently been seen with less scientifically applied pressure it must be admitted that grafts which are viewed on say the 5th or 7th day have been occasionally observed to undergo first œdema and subsequently some form of trophic loss. So that if

the pressure is still being successfully applied and there is no other reason to disturb the dressing my present inclination is to follow the ideal Possibly some electro-therapeutic method may supplant this pressure method of preventing œdema

The final colour of these grafts is not uniform In some cases they take on a brown sunburnt appearance difficult to explain while in others they never lose the somewhat glaring whiteness which robs them of much of their cosmetic result The art of colour tattooing has a very definite place in plastic surgery Wolfe grafts do best in positions such as the forehead where it is possible to obtain good pressure-dressing They fail to do so well when placed on yielding and mobile tissues where adequate pressure-dressing is not so readily applicable. However by the latest methods of pressure-dressing even this difficulty has to a large extent been overcome

Pressure methods.—Mention must be made of the *Coelst method* of providing pressure. He aims at stretching the base of the graft by suturing a frame of celluloid to healthy skin some distance from the margin of the wound Round this frame tapes may be passed and tied over a mould of the raw area Undoubtedly good results are obtained but the principle is not different from that of leaving long ends of sutures to tie over sponge or stent mould and has the disadvantage of being more complicated with a risk of distant stitch marks

Perhaps the best of all pressure methods for a Wolfe graft (combining the advantages of all) is to make a frame that fits outside the wound area out of a rope of black guttapercha. This when laid on soft will take up the contours of the wound surroundings and when set will represent a firm ring following the contours It should be about a third of an inch thick. After the graft has been sewn into position some long-ended sutures are tied to this frame and will produce centrifugal traction on the base of the area to be grafted The ends are still left long after the knot has been made and can be used to tie down the sponge on to the mould and so produce an elastic and even pressure on the graft. The method of inducing the skin-graft to adhere to its bed by the production of an immediate fibrin clot has not succeeded in the elimination of the need for complicated and time-consuming fixation

Fat-grafting—Pieces of fat are best obtained from the abdominal wall or buttock Deep catgut anchoring-sutures should always be avoided if possible and careful hæmostasis and accurate apposition of the skin-edges over the graft are of extreme importance. Asepsis should be very carefully attended to throughout for the transplant is especially liable to infection. As fat varies in its fluid content, one third allowance should be made for its contraction. Old fat-grafts of several years standing show more fibrous tissue than at the time of transplant but their survival cannot now be disputed The same principles apply to the firmer dermo-lipomatous grafts in which the sheet of fat is left attached to the deep layer of the dermis

Paraffin injection which is a quick and easy method for adjusting contour defects should never be used This injection leads to intractable paraffinomata with wide infiltration into the tissues the surgical removal of which is often impossible without great mutilation

Fascia lata graft.—The most common condition for which these fascia lata grafts is required is *facial paralysis* A great deal of work in connection with the cure of this distressing condition has been done all over the world At present the possible treatments appear to be as follows —

Nerve-grafting and nerve anastomosis —Whenever this is possible it should take precedence over any attempt to alleviate the condition by the insertion of fascial bands It has been pointed out however

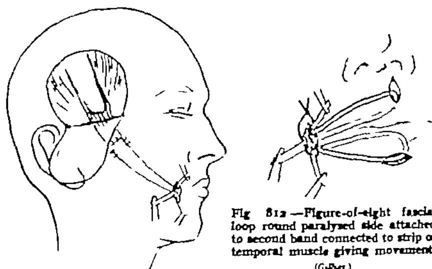


Fig 812 —Figure-of-eight fascial loop round paralysed side attached to second band connected to strip of temporal muscle giving movement. (Gillies)

that when there is no galvanic response there is then a clear contra indication to any nerve grafting and cases of many years standing usually fall into this category

Fascia lata supports.—Where nerve grafting is contra indicated these fascial supports have a very definite value Before their insertion care should be taken to eliminate all septic foci from the patient s buccal orbital and nasal cavities If the paralysis was caused by mastoid disease everything possible should be done to make the mastoid cavity aseptic The fascial strips are obtained from the fascia lata of the thigh by one of the well known methods that recommended being by the use of a ring stripper and fascia cutter Fascial strips are then placed in loops in such a way as to take a hold on the muscles of the sound side of the upper and lower lips and of the corner of the mouth The loops are passed by means of the Blair fascia needle through tiny incisions The fixation point is usually the pre auricular fascia A satisfactory support is obtained by this simple operation and there is both objective and subjective improvement (Figs 812 818)

Activation of the face by attachment of fascia lata to temporal muscle flap.—Activation of the facial muscles is possible by attaching the temporal muscle to the band and loop in such a way that when it contracts voluntarily movement of the face occurs simulating facial expression

Activation of the paralysed eyelid.—In 1917 a method was described of using temporal muscle and fascia to take the place of lost malar and lower eyelid muscles Its bulk provided contour and its movement some expression Since then many improvements have been made. The use of the temporal muscle and its fascia is a satisfactory method of obtaining muscular movement for the paralysed eyelid. A flap of muscle is cut rather far forward and a considerable amount of temporal fascia is taken with it. By splitting this fascia it may be made sufficiently long so that while still attached to its original muscle a strip can be passed to the upper and lower lids to meet at the inner canthus This little flap squeezes the two eyelids together The muscle action is as a rule not very strong but quite sufficient to give a definite support to the lower eyelid



Fig. 813.—Scheme of simple fascia lata bands used in facial paralysis. (*After Blair.*)

Cartilage-grafts.—After the usual preparation of the skin an incision 4 to 6 in. in length is made perpendicularly over the central point of the ascending portion of the 7th costal cartilage preferably on the right side of the body A transverse incision gives a worse approach but a better scar This is carried down through skin subcutaneous fat the rectus sheath and muscle and the glistening surface of the underlying cartilage is exposed By suitable retraction of the muscle on either side of the incision good exposure may be obtained and by working with the rugine around the lower border and deep surface of the cartilage the portion to be removed is easily isolated from its muscular attachments Considerable variety in the shape and size of the cartilages in this region is met but as a rule the lowest cartilage seen represents the anterior slender extremity of the 8th while the first complete cartilage crossing the wound is the more bulky 7th The former is usually insufficient for the larger restorations but is commonly taken and stored as a spare fragment In cutting through either cartilage the rugine is introduced on its deep aspect to protect the underlying structures Wrapped in a moist sterile towel the pieces of cartilage are put on the small table set apart for the sculpturing which they must undergo before they reach their final destination It is now that the hinged cartilage-graft can be fashioned, in which the perichondrial strip binds the columella strut to the thicker bridge line

support The rest of the perichondrium is removed and providing that the cartilage is straight the method is advocated for the saddle nose with the collapsed bridge Bleeding vessels having been ligatured, the wound is closed in the usual way Any useful fragments of cartilage left over at the end of the operation are buried subcutaneously according to a method adopted in 1917 in a pocket in the abdominal wall The right iliac quadrant is the best region for in this position the cartilage appears to give least trouble to the patient of either sex. Smaller restorations of nasal contour are sometimes effected by septal cartilage while an alar support or one for the stiffening of an eyelid can conveniently be taken from the concha of the auricle with or without the overlying skin.

Bovine cartilage is now available prepared and sterilized. Recent work shows that it appears to be well tolerated by the tissues and is used for building up contour defects Slow absorption occurs in some cases.

Chondro-cutaneous grafts.—It has been found that composite free grafts from the pinna which include both skin and cartilage survive satisfactorily and can be used in the reconstruction of marginal alar and columella defects

Bone-grafts.—The ease with which cartilage can be obtained and cut to any required shape and size makes it popular in every branch of plastic surgery where restoration of contour is the main and only object of operation However much experience shows that it is very liable either to a change of position after implantation or to a change of shape The degenerative process produced in the graft occurs unevenly and too frequently with an ugly result To avoid this the shaped iliac bone-graft has become the common graft for depressed nasal bridge. It is easily obtained and shaped gets firm bony union with the bony bed to which it is attached remains straight and if as rarely it becomes mildly infected it will resist destruction In constructive rhinoplasty however where the whole nose has to be re-built, cartilage in the form of thin strips for the alar support and thick strips for the bridge support is still recommended (*see* p 1978) For restoring lost portions of the mandible iliac bone grafting is an established procedure and is here briefly described

Before operation the fragments of the jaw are fixed by metal cap-splints and suitable bars fixed to the teeth in a position as nearly as possible approaching that of normal occlusion The gap is thus well defined when the ends of the fragments have been exposed and freshened It must be emphasized however that the posterior fragment (especially if edentulous) has usually been pulled forwards and inwards and should be freed so that the inter position of the bone-graft will push it backwards and outwards into normal position. A submandibular incision is made if possible in the line of and at the same time excising a previous scar After careful protection of the skin-edges by towels the wound is gradually deepened by excision

of the dense scar tissue usually present between the fragments Deep tissue flaps are preserved as far as possible to provide covering for the graft The ends of the fragments having been cleared and defined by the careful use of knife and rugine freshening is carried out by means of bone-nibbling forceps or other suitable means until healthy bleeding bone is reached The clearance of the lingual side of the bone is greatly facilitated by placing the index finger of the left hand in the mouth and dissecting on to it Laceration of the oral mucosa is prevented by using this technique The gloves should be changed Near the angle of the jaw where the bone is thin the outer surface must be extensively freshened if union is to follow When this freshening process is complete and the ends of the fragments have been drilled to take sutures of stainless steel wire the gap is ready to receive the graft and all that remains is to plan and cut the latter and fit it in position by the ordinary rules of carpentry A rough model or templet is made in tinfoil or thin sheet lead the length and shape of the bone required

The hip region is now prepared With the patient turned well over to the side opposite to that from which the graft is to be taken a curved incision convex downwards so as not to lie directly over the crest is made down to the fascia covering the gluteus maximus and the upper skin flap is reflected The outer edge of the crest being used as a guide the gluteal fascia is divided and the upper fibres of the muscle are separated from the bone in such a way as to expose the outer surface of the ilium to a depth of about 1 in over the extent required The templet is placed in position and outlined on the surface of the bone by chisel and mallet These cuts are deepened until they extend through half the thickness of the ilium when a wide thin chisel or osteotome driven downwards from the upper surface of the crest completes the separation of the graft With Lane s bone-holding forceps the graft is transferred to a small table set apart for final trimming and drilling The hip wound is closed by deep and superficial sutures drainage is always advisable

The portion of bone removed consists of the outer cortical layer and half the thickness of the medulla of the ilium. Its texture is very similar to that of the normal mandible and the half thickness graft is about the same bulk as most parts of the mandible for which grafting is required There is no necessity for taking the whole thickness of the bone a procedure causing much greater interference with muscular attachment The graft is so cut that its anterior extremity may be fixed to the posterior fragment of the jaw and its posterior end to the anterior fragment while the crest portion lies downwards and the cortical surface outwards The ends of the graft are fashioned so as to fit the areas freshened for their reception as accurately as possible and it is upon this part of the operation that much personal ingenuity has been lavished Drill holes are made to correspond to those of the freshened extremities and the graft is transferred to its bed and wired in position by mattress sutures

The deep tissue-flaps are drawn together by catgut sutures so as to make a good covering for the graft and the wound is closed in the usual way drainage being seldom necessary

The time for which it is necessary to retain the splints varies considerably In most cases they have been kept in position for from six weeks to two months Though authorities on the subject have lately advocated very early removal I am not convinced that this procedure though it tends to early restoration of function ensures the best occlusal results unless some other means of preventing recurrence of the original deviation of the fragments can be planned Union of the graft is usually well advanced at the end of the second month and the new portion of jaw continues to get stronger as it takes on active movements * Recently excellent results have followed the use of multiple chips of the cancellous portion of the ilium † The principle of this method was originally introduced and practised by Sir William Macewen ‡

SKIN FLAPS

No useful purpose would be served by a detailed description of all possible skin flaps There are several basic principles however which may serve as a guide to this useful and elegant form of repair In general there are two types of flap the local flap which is a one stage surgical procedure and the flap from a distance which may require two or more stages for its completion.

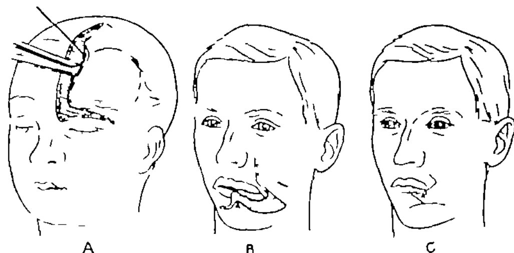


Fig 814

A, undermining of flap for simple advancement. B, C, transposed flap. This example shows raising of corner of mouth.

The local flap —These flaps make use of tissue adjacent to the defect to be closed and are transferred after thorough mobilization by advancement rotation or transposition Whichever method is

* Gillies and McIndoe, The Late Surgical Complications of Fracture of the Mandible *Brit. Med. Journ* Dec. 9, 1933, ii, 1060.
† R. Mowlem, Cancellous Chip Bone-Grafts—Report on 75 Cases, *Lancet*, Dec. 9, 1944, p. 746.
‡ *Ann. Surg* 1907 vi.

used the elasticity of the skin and the redistribution of tensions play an important part in their design and management If the secondary defect left after transposition of the flap cannot be closed without undue tension a suitable free graft should be applied but ingenuity in design of many of these flaps will leave this defect in lax tissue where closure by direct suture is possible Examples of local flaps are shown in Figs 814 and 815

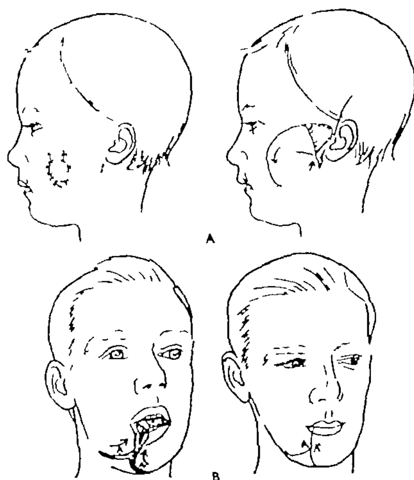


Fig 815

A, rotation flap B, double advancing VY flap Type to cure defect of lower lip.

Flaps from a distance.—These flaps utilize tissue not immediately adjacent to the defect to be closed and include the direct pedicle flap They may be transferred without an intermediate host such as the forehead flap to nose or cheek the scalp flap to eyebrow or chin and the neck or acromio-pectoral flap to the face The cross-finger and cross leg flap come into this category With the forearm or wrist as an intermediate carrier flaps may be transported to virtually any part of the body surface and large amounts of tissue can be moved by this method. (*See* Fig 816)

The Gillies tubed pedicle flap (*Figs 816 817*) —The principle of this flap was evolved in October 1917 when the plastic surgeon was confronted with the difficulties of restoration of considerable portions of the skin of the face in severe burns No facial flaps were available so that skin had of necessity to be brought up from more or less distant regions The difficulty of obtaining a sufficiently certain blood supply was overcome to a great extent by the method described

As an example let it be supposed that the transfer of a large area of skin from the chest to the face is indicated. It is necessary to

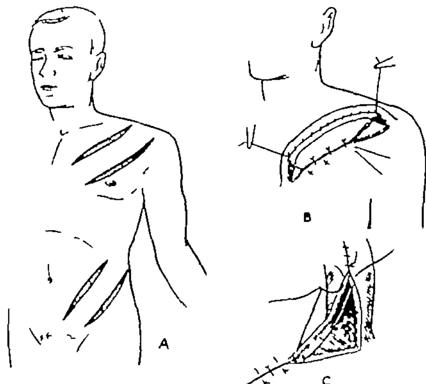


Fig 816 —Tubed pedicle flap.

A, common donor sites for tubed pedicle flaps the acromio-pectoral, especially in males, and the oblique inguinal B, suture of tubed pedicle flap. C, fourpoint suture. Triangular raw area t each extremity

provide a flap whose pedicle shall be situated somewhere in the region of the base of the neck A strip of skin usually about 2½ to 3 in. in breadth is raised from the neck and upper part of the chest (Fig 816 A) its upper and lower extremities being left attached. The two edges of this strip are accurately apposed by a continuous fine suture while the margins of the raw surface remaining are freely undercut in order to allow them to be brought into apposition by suitable tension and other sutures (Fig 816 B) This latter procedure is facilitated by raising the shoulder on the side from which the flap has been cut and inclining the head towards it When the flap is broad and the secondary approximation at all difficult it is better to skin-graft the raw area. The flexibility of the resultant epithelium is truly astonishing

The flap now forms a sausage-like tube of skin attached to the body at its two extremities After about three weeks the lower end of the tubed flap may be separated from the chest and being opened out to



A



B



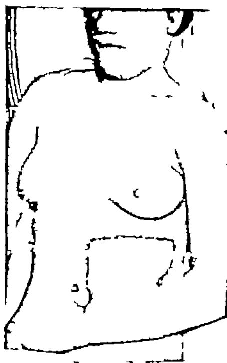
C



D

Fig. 817 —A, airman's burn, 1917 B an early branched pedicle for (C) lip nose, and right cheek. D result.


A


B


C


D

Fig. 818 —A, severe burn contractures. B preparation of direct flap. C, transfer D result.

the required amount may be applied to and sutured in position on the area to which it is to be grafted (Figs 816 C 817)

After a further period of three weeks the upper end of the pedicle may be likewise separated and spread over some other part of the face depending now for its blood supply on the previously grafted lower end. Various other transfers may be made after suitable intervals of waiting until the tube is completely used. If after the first transfer no further skin is required the pedicle portion is divided from the part grafted and replaced in its original position on the side of the neck

By means of the tubed pedicle skin may be brought by stages from almost any part of the body to a desired spot and it is in this respect that its introduction may be considered the most important advance in plastic methods which has been made in recent years

Direct pedicle flap method.—In transferring a direct full thickness pedicle flap from one part of the patient to another it is necessary to pay particular attention to its accurate design in order to avoid danger to the blood supply The direct flap method is advantageous in that the number of essential operations is reduced to two with an interval of two or three weeks thus shortening the length of stay in hospital very considerably

The principle of the method of accurate design is to imagine the operation completed and to reverse the steps of the procedure of transferring the flap using as a model an exact jaconet or linen pattern of the defect to be covered. It is thus possible to arrive with speed and accuracy at the correct topographical origin of the flap to be cut from the donor area Suppose that there is a rectangular area over the posterior surface of the elbow joint to be covered by a direct flap taken from the side of the abdomen After the usual pre-operative preparation and sterilization of the pattern the elbow is flexed and approximated to the side bringing the defect as close as possible to the donor area. The pattern is now fitted accurately to the defect. The assistant holds the lateral edge carefully in position while the medial edge is turned over on to the abdominal skin and held by the surgeon in the position which it naturally takes so as to leave the intervening portion comfortably slack. The lateral edge of the pattern is then released and the arm moved away from the side while the surgeon smooths the remainder of the pattern over the abdomen The skin outlined by the pattern is marked by scratching and dissected up to form a flap the attached side of the flap on the abdomen corresponding to the edge of the pattern first shifted to the body It is necessary in some situations to allow enough extra skin at the base of the pedicle to ensure a sufficiently large area of the flap being sutured in position After two to three weeks the attached end of the flap is divided and sutured into position on the arm The line of division can be readily marked out by placing the pattern in position over it (Fig 819)

The advantage of the method will be realized in direct transfers from limb to limb such as calf or ankle to opposite leg or thigh It will be

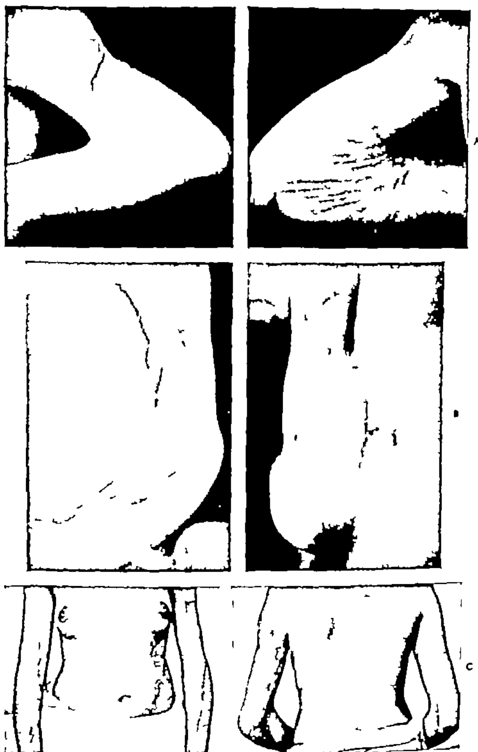


Fig 819

A, burn contracture of ante-cubital space B and C, cure by direct lateral trunk flaps. Note in the back view B the temporary utilization of the scar tissue as means of fixation.

found a great comfort to know that the flap will fit its new bed accurately without its having to be pulled into place by overstretching some portions or inserting stitches which exert considerable tension Gangrene and removal of stitches are thus largely avoided Plaster fixation is essential for cross limb flaps

The same principle of reversing the operation is applicable in making the design for all tubed pedicle transfers but it is not quite so essential owing to the great mobility and vitality of these flaps *

LYMPHŒDEMA

Chronic lymphœdema arising from a variety of ill-defined causes may be considered to be amenable to surgery The types most frequently met with are in the lower limb idiopathic or lymphœdema præcox post thrombotic traumatic and Milroy s disease Idiopathic lymphœdema may affect the external genitalia. In the upper limb the commonest cause is radical mastectomy with or without irradiation The face may be affected when it is usually the sequel to infection such as a severe cellulitis

The classical method of treatment is of the Kondoleon type in the leg This consists of free excision of the subcutaneous tissue and deep fascia uniting the skin directly to the muscles The principle behind this treatment is that the lymph of the limb is drained away through the muscles. It also has the advantage of removing the irreversible œdema. The results vary in different clinics but most observers agree that even in the good cases a mild recurrence is likely This can be controlled by bandages The Kondoleon operation should therefore be attempted in most cases (*See* p 611 Vol. I)

A second experimental method is to insert a piece of skin with its lymphatic vessels the valves running in the right direction across the line of the block Thus in conditions of the leg and thigh a flap of skin from the inner aspect of the arm and the anterior aspect of the forearm is grafted from the inguinal to the mammary region so that the lymph runs up this bridge and is drained to the neck via the axilla It is too early to assess the value of this operation but it is a favourable proposition in certain cases That it has been a complete cure in a few patients is without doubt In the arm conditions a bridge of skin must go from below the axillary block to the root of the neck and this bridge must contain the necessary lymph valves A method that has been used five times is to swing over the opposite breast to give drainage to the arm Thus the lymph of an œdematous right arm may be drained through the left breast into the left axilla. All the cases in which this has been done show marked improvement Unfortunately two of them were already suffering from neoplastic metastases at the time the operation was undertaken

A similar procedure is applicable to the idiopathic lymphœdema of the lower limb when the iliac lymphatic block is bridged by moving

* Gillies, The Design of Direct Pedicle Flaps, *Brit. Med Journ.*, Dec. 3 1932, ii 1008.

down a thoraco-abdominal pedicle flap which contains ascending lymphatics This is inserted across the inguinal region and drains lymph up to the axillary region It is combined with a surgical reduction of the œdematous subcutaneous tissue of the leg

Recently much more emphasis is being given to excision of the œdematous tissue This entails a total ablation of the subcutaneous layers of the limb which is then resurfaced with its own skin in the form of a free skin graft This technique can be applied to either upper or lower limbs In the face and genitalia much improvement can be expected from wide excision of the fibro-œdematous masses *

DEFORMITIES IN UPPER LIMB

Deformities to the Hand following Injuries to the Skin

Burns of the hand.—In this condition there is frequently scar tissue contracture of the fingers Whether only the palmar surface of the fingers or the whole of the palm be involved the usual method of treatment is a free graft As regards function there is little choice between a thick split-skin graft and a Wolfe graft, but cosmetically the latter may be preferable It is however more difficult to apply When it is found necessary to graft the flexor surface of a finger it is usually desirable to carry the graft on to the side of the finger so that any subsequent tendency of the joining scar to contract will not result in flexion deformity There is a common conception that a free graft on the palm of the hand does not subsequently withstand manual labour There appears to be no ground for this

On the dorsum of the hand the same types of graft are desirable except in rare instances When tendons are exposed it may be preferable to utilize a flap in order to provide a pad of subcutaneous tissue which will prevent adhesion between the tendon and the skin. These abdominal flaps are however as a rule too bulky to give good cosmetic result

Recent trauma of the fingers.—In glove avulsion of the cutaneous coverings of the finger the best treatment is the immediate application of a free skin graft A more common condition is the oblique amputation of the tip of the finger including perhaps the top of the nail together with the whole of the pulp The phalanx is exposed and if these cases remain untreated their convalescence is slow and the end result unsatisfactory Cases have been recorded of the immediate resuture of the detached fragment plus the application of pressure. As a general rule the tip will survive In the more extensive cases or where the detached fragment is not available the immediate application of a Wolfe graft after trimming back the exposed surface of the phalanx is desirable In very severe cases it may be wise to attach a small abdominal flap to restore the subcutaneous pad on the finger tip †

* Homans, J (1936) *New England J Med* 215, 1099 Mowlem, R. (1948). *B J Plastic Surg* 1 48 Pratt, G H *J Amer Med Ass* 147 1121

† See also Autograft of Amputated Digit, *Lancet*, 1940 i, 1002.

X ray burns.—These usually involve the dorsal aspect of the hand or fingers. Excellent results are obtained by free grafts usually of the thicker type (p 1061)

Thenar flap repair —In cases of finger tip avulsion with extensive bone exposure or destruction and loss of support to the nail bed the thenar flap repair will be found to be entirely satisfactory The injured finger is placed down on to the thenar eminence in the position of maximum comfort a flap of skin and the firm subcutaneous tissue is outlined, the pattern being taken from the raw surface of the finger This flap has a proximal base on the eminence and will be found to have an excellent blood supply The defect left by the raising of the flap is closed by means of a Wolfe graft cut from the upper arm and the flap itself is sewn to the edges of the finger defect the distal stitches being put through the free edge of the nail A small wool dressing is placed in position between the volar surface of the finger and the skin graft on the thenar eminence and by this means normal steady pressure is applied to it

The position is maintained by a plaster of Paris wrist band an extension of which passes across the dorsum of the hand and finger to the volar surface of the wrist where it becomes again continuous with the wrist band. The hand remains undisturbed for two weeks after which time the base of the flap is severed from its thenar attachment and is sewn to the proximal edge of the finger defect A linear wound will then be left on the palm of the hand and this is closed by suture of the free edge of the Wolfe graft to the opposing skin edge

In the course of three to six months reshaping of the new tip takes place and an adequate sensation returns If the flap has been cut accurately and there is sufficient bulk of subcutaneous tissue a good anatomical reconstruction can be expected.

Loss of digits.—Probably the chief indication for operative interference is the presence of a functional thumb in the absence of any structure to which it may be satisfactorily apposed. In these cases it is wise to extend the stump of the hand in the region of the index finger either by a tubed pedicle or an abdominal flap This prolongation is subsequently stiffened by the insertion of a bone graft into the distal end of the first metacarpal. Occasionally this procedure may be carried out on the ulnar border of the hand as well as on the radial border The cosmetic results are not necessarily good but the functional result is satisfactory

The other indication for operation is the *presence of normal fingers* and the absence of the thumb If the metacarpal is intact a short prominence may be added to give successful apposition to the finger tips Where the thumb metacarpal is intact the operation of phalangization may be employed. The web between the thumb remnant and the index is deepened and lined with a thick split skin graft. This increases the mobility of the stump and makes it a more efficient opposition post The bone-graft should be set into the metacarpal

at a slight angle of adduction prolongation of the metacarpal is thus obtained and is most satisfactory Recently the operation of pollicization of the index finger has proved a practical and successful procedure *

Autograft of an amputated digit—Replacement of amputated digits by direct resuture fails to ensure their survival because revascularization is too slow to prevent necrosis of the severed tissues It is suggested that if the skin nail and subcutaneous tissues are removed from the severed digit leaving only the skeleton and its tendons and it is then buried in a subcutaneous pocket there would be a reasonable chance of a new blood supply becoming available to the deeper structures.

Technique—The stump of the finger is prepared by an oblique excision of normal skin thus creating a relatively large raw area on the dorsum The amputated portion is carefully cleaned and the integument and nail are dissected away exposing phalanges joints and tendons The periosteum is sutured across the line of fracture and when the tendons are approximated, some stability is acquired. A careful suture of the two digital nerves then completes the union of the severed part with its host

The most suitable site for the receipt of the finger is beneath the subclavicular skin where the connective tissue is sparse and firm and the skin is thin and well vascularized In the female it might be well to choose the abdomen to avoid obvious scarring Having chosen the most suitable site a curved incision is made and a subcutaneous pocket is created, the plane of cleavage lying just under the dermis and the finger is inserted The curved edge of the incision is carefully sutured around the margin of the skin defect on the finger and the hand is immobilized to the trunk by strapping

After two weeks a flap 8 in. wide is outlined by a scalpel scratch on the skin with the finger lying to one side of its midline. The lateral margin of the flap farthest from the finger is incised and the skin wrapped ventrally round the finger to which it is then attached by several stitches A week later the remaining lateral incision is made and the flap margins are sutured together along the lateral side of the finger There remains now only the tip attachment which is divided and inset at the fourth week.

A refinement of this procedure which may be used when the skin of the amputated digit is not lacerated or crushed is to preserve it as a free graft by implanting it on the thigh It can later be dissected off and reapplied to the finger with a view to establishing normal digital sensation.

If there are reasons against making this operation an emergency repair it is hoped that the amputated digit could be preserved by trimming it as described above and inserting it into a small subcutaneous pocket under local anæsthetic Care should be taken in choosing the

* Gillies and Cuthbert, Plastic Surgery of Burns of the Hand, *Medical Annual*, 1943

When the contracture is slowly advancing over a period of years and shows as one or more discrete bands passing from the fingers to the palm, multiple fasciotomies done with a tenotome under local anæsthetic can be expected to give good results. This may be done in several sessions and the patient should be warned that treatment may have to be repeated if further bands appear.

In more rapidly advancing cases and in those with massive fibrosis and nodule formation a formal fasciectomy is indicated. The operation should be designed to remove all the thickened and contracted fascia. The approach to the palm should be through a zig-zag incision over the centre of the contracted mass. No incision should cross the palmar skin pads at the bases of the fingers, but apart from this incisions should be designed to give the best exposure for the case. This operation is done under a tourniquet and speed is essential so that tissue anoxia is not unduly prolonged. There is little doubt that it is a contributory factor to the post-operative stiff hand.

Finger incisions may be Z or lateral U shaped, whichever suits best. The fascia is dissected away starting proximally in the palm and working down to the fingers. The skin after removal of the fibrous tissue is often very thin, but with these incisions and the avoidance of large flaps necrosis is a rarity.

Complete hæmostasis is essential and a moderate pressure dressing and 48 hours' elevation help to control the œdematous reaction.

Where there is gross contraction of the fingers an estimate should be made as to whether the joints are reparable or not. If not, amputation of the finger may be indicated. If there is a gross contracture with a short history, a two-stage operation is useful. At the first stage local fasciotomies are done so that with post-operative exercise the fingers may be partly straightened. This not only allows easier access for the second stage fasciectomy, but the condition of the palmar skin, often contracted, moist and infected, can be much improved before the major procedure is done.

Rarely the skin is so involved that replacement is necessary and a thick split skin graft is usually used on these occasions.

Deformities of the Forearm and Axilla following Injuries to the Skin

Forearm.—These deformities are chiefly the result of burns or extensive lacerations. Contracture in the region of the antecubital fossa is common. In the male this may be efficiently treated by a free graft. In women, however, where the cosmetic result is important, it is frequently desirable to replace not only the skin in the region of the antecubital fossa, but also that of the whole of the forearm. This is best done by a flap from the flank with joining lines on the radial and ulnar borders of the arm (*see* Direct flap, p. 1965). The same type of flap is sometimes desirable in cases of extensive laceration with involvement of the muscles, particularly when these are tending to

contract as the result of fibrosis The cosmetic results of these abdominal flaps to arm or forearm are so natural that it is difficult to distinguish which is grafted and which is non-grafted skin

Axilla.—These also are usually the result of burns When the axilla is occupied by a dense mass of fibrous tissue and the arm is closely bound to the side the initial treatment consists in division of the scar probably without removal of any tissue The arm is adducted and the resultant raw area free-grafted Secondary webs in either the anterior or posterior axillary fold regions may frequently be dealt with by extensive Z plastics The incisions of this plastic usually require to be so wide that it is impossible to cure a contracture of both folds at the same sitting Occasionally there is insufficient material in the axilla for a Z plastic to be practicable. In these instances a rotation flap from either the anterior or posterior surface of the body may be useful

RHINOPLASTY

The case of the patient who from disease or injury has suffered loss of the whole nose will be taken as an example It should be easy then to see how the method of dealing with such a case may be modified to suit individual less extensive cases I do not propose to give a historical outline of rhinoplasty nor to describe methods necessarily based on isolated cases which appear unsatisfactory on theoretical or on practical grounds

In no branch of plastic surgery is the principle of *restoration in kind* of greater importance skin supporting structure and epithelial lining must all be provided if the cosmetic result is to be at all permanent

The operative treatment may be divided into the following stages

1 Preliminary establishment of air way
2. Subcutaneous implantation of cartilage to form scaffolding
3 Rhinoplasty proper
4 Return of the pedicle
5 Skin-grafting of the forehead general trimming and final contour production

Stage 1 —As the lining of the new nose is to be formed by turning in small flaps from those areas of the face bordering on the defect it is essential that these latter should carry an efficient blood supply drawn from the mucosa upon which they abut To this end all scar tissue around the defect is carefully excised with exact apposition by accurate suturing of mucous membrane to skin. It is at this stage in cases of subtotal loss affecting the upper part of the nose that the lower or terminal segment which has usually become considerably displaced upwards by contraction during the process of healing is thoroughly freed and allowed to take up its original and normal position.

Stage 2.—It is frequently possible to combine this stage with the former Cartilage or bone having been taken a thin flake about $\frac{1}{16}$ in thick $\frac{1}{4}$ in wide and in length equal to the extent of bridge it is required to replace is inserted subcutaneously in the glabellar region. The insertion is best accomplished through a tiny incision in the midline between the eyebrows or higher up on the forehead according to the length required The cartilage is pushed downwards until it almost reaches the upper margin of the defect (Fig 820 A)

Stage 3 —After a minimal interval of twenty-one days the rhinoplasty proper may be performed A flap from the glabellar region is turned downwards as in Fig 820 B to form the central portion of the

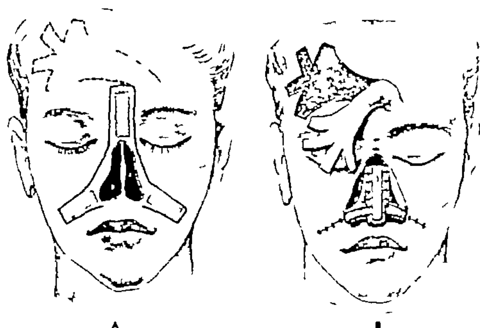


Fig. 820 —Rhinoplasty

A, Airway established supporting cartilages implanted. The outline of both lining and covering flaps has been indicated B, Lining flaps turned in and sutured; forehead flap raised.

lining of the nose. This flap carries on its deep surface (now outer most) and is supported by the cartilage previously implanted. The alar portions of the lining are formed by lateral flaps turned inwards from positions on either side of the face above the upper lip as shown in Fig 820 B In order to maintain the curve of the nostril it is of distinct advantage to implant thin strips of cartilage in the regions from which these flaps are taken in Stage 2 Figs 824–827 show alternative methods of carrying out this part of the operation

The remainder of the lining is formed by small flaps turned in from the remaining margin of the defect. All these flaps should be worked out previously on the plaster cast of the patient in order that the most may be made of the scanty tissues available The adjoining margins of the flaps are united by catgut sutures of the Lembert type intro-

duced in such a way as to invert all skin-edges slightly into the nose Where possible it is strongly recommended that the covering flap should be obtained from the forehead by the modern modification of what is usually known as the Indian method Fig 822 illustrates the incisions used for marking out such a flap An exact model of the skin required should be made in tinfoil and this should be placed on the forehead in such a position as to allow a pedicle sufficiently long to bring down the flap without any undue kinking at its point of attachment. Latterly this pedicle has been made somewhat sickle-shaped in order to carry it well clear of the eyebrow Warning must be given against allowing a narrowed portion to occur at any point of flap or pedicle

That portion of the flap destined for the nose itself should be cut of such a thickness that it reaches into the subcutaneous fat only In

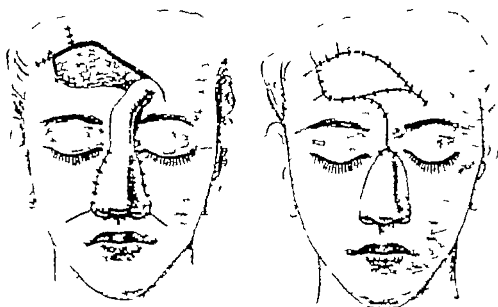


Fig 821 —Rhinoplasty later stages.

A, Forehead flap sutured in position over lining and supporting cartilages. B, Pedicle of flap returned to forehead. Remainder of raw surface covered by Wolfe skin-graft.

special cases where a thicker nose is required aponeurosis and muscle may be raised The pedicle portion should always extend down to the aponeurosis. The flap is now swung down and accurately sutured to the margins of the raw area which have been sparingly undercut in preparation. The raw surfaces left by the raising of the alar lining flaps are closed by approximation of their edges No tubes or other supports are introduced for it has been found that instead of maintaining the airway these tend to produce ulceration and consequent stenosis. A smearing of sterile liquid paraffin over the suture lines in the region of the alæ has been found of great advantage in preventing crust formation Any bleeding vessels in the raw surface on the

forehead are ligatured and the wound is dressed with a split skin graft which should be carefully arranged so as not to press upon the point of turning of the pedicle In many cases the pedicle can be let in in the glabellar region in other cases this area is closed by approximation and the pedicle tubed

Stage 4.—After a minimal period of two weeks the pedicle may be returned to its position on the forehead This procedure requires no description beyond saying that the portion of the pedicle adjoining the flap is divided in an inverted V-shaped manner and that any granulation tissue which has formed on the forehead in the region to which it is to be replaced is excised.

A minor plastic rearrangement will be called for in which the upper portion of the flap is made to lie snugly in the area between the eyebrows

Stage 5—The split skin graft mentioned above may be replaced by a Wolfe graft cut usually from the upper limb and sutured in position



Fig 822
Forehead rhinoplasty (up and down method) Folding of forehead extremity to form nostrils and columella

on the forehead by a carefully-applied continuous stitch This procedure may form part of Stage 4 but it is better if possible to leave it until now in order that the graft may have four instead of three vascular margins to which it may be sutured Any minor trimming operations in the alar region are then carried out and a piece of cartilage from the store suitably shaped is inserted from above after careful undercutting of the flap in order to give the final contour desired.

The Columella

Here is a simplified and safe method of shaping columella and alæ. Fold the extra 1 in of flap loosely back on itself leaving it flapping at the end of the new nose without attachment to lip The excess of the alæ margins thus formed is at four weeks utilized to form the columella

and elevate the tip Plunge a No 11 blade through the flap 1 cm on either side of the midline and 1 cm back of the edge and carry it out to the fixed ala base

Thus two little flaps attached to the new lobule and lying horizontally are turned down into the vertical and pressed together with sutures to make the columella This type of repair may be used for cases of destruction or intra nasal retraction of the columella with excellent results If the new alar margins are carefully sutured little or no visible evidence remains that they have been the donor sites for the reconstruction

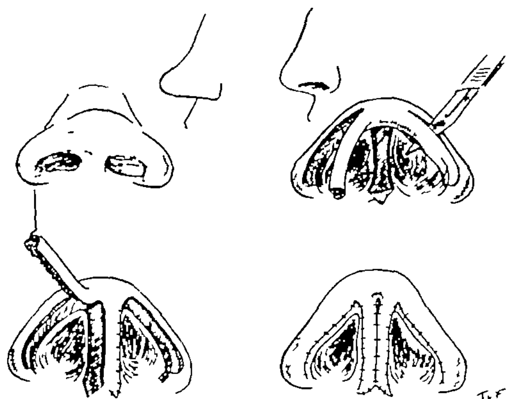


Fig 823.—Bilateral alar margin flap method.
(From Brit. J Plastic Surg)

A flap based on the superficial temporal artery has distinct advantages in the treatment of female patients for the whole of the scarring which it produces can be easily hidden by suitable dressing of the hair (Fig 828) It is also used of necessity when the central part only of the forehead is available.

Skeletal Deformities of the Nose

Depression or asymmetry of the skeletal portions of the nose may occur as the result of congenital deformity disease or trauma. Care must be taken not to undertake any plastic repair during a period of active disease

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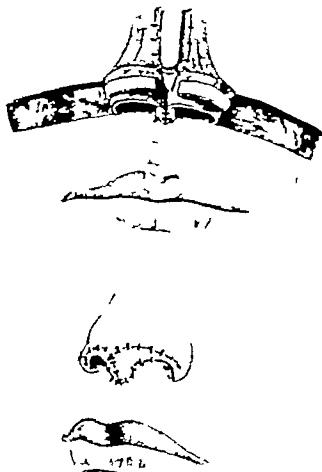


Fig 824.—Formation of alæ and columella from long inturned flaps. The alar portions of the flaps are supported by previously implanted strips of cartilage

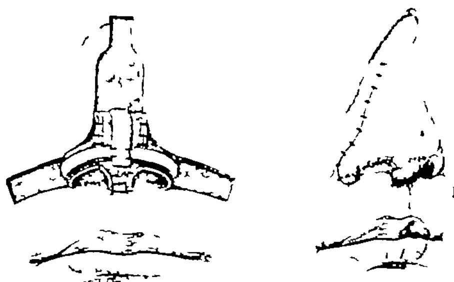


Fig 825.—Reconstruction of columella partly from inturned flap and partly from covering forehead flap.

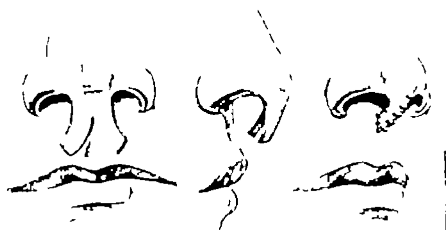


Fig 826 —Reconstruction of columella from forehead flap

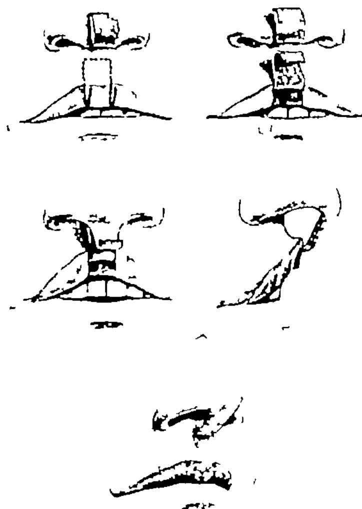


Fig. 827 —Reconstruction of columella from upper lip



Fig. 828 —Partial destruction of nose following lupus. Rhinoplasty by forehead flap based on the superficial temporal artery
Photograph shows how readily all scarring is hidden by suitable dressing of the hair
(Gillies *Plastic Surgery of the Face*)

Depressed fracture of the nose —One of the most common accidents both on and off the road is depressed or lateral displaced fracture of the nasal bridge This type of injury shows little or no loss of the supporting structures If the case is seen any time in the first three weeks after the accident the nasal arch can usually be manipulated into normal position Too much emphasis cannot be laid on the necessity of giving the patient general narcosis Using Walsham s forceps for the sides of the arch and Ash s forceps for the septum both the dislocation of the latter and the impaction and displacement of the nasal bones can be rectified and septum and bones manipulated into position It is well to fit over the replaced nose a small mould of dental composition over which a piece of malleable lead plate is fixed A satisfactory splint can also be made from plaster of Paris bandage A 4 in Cellona bandage is folded upon itself in 6 in lengths ten times From this is cut a pattern which accurately fits over the nose continues up over the glabellar region and spreads out as two wings one on each side of the forehead to the temporal hair line The eyebrows are greased and the splint applied and allowed to set It is held in position by two tapes tied round the head one across the forehead and one across the nasal bridge This should be worn for two or three days to prevent excessive swelling and to maintain the position

Restoration of the nasal bridge is indicated when there has been actual or potential loss of the bony and cartilaginous make-up This often occurs after very heavy septic compound fractures dish face deformities specific ulceration of the mucous membrane and bone and submucous resections that have been unfortunate enough to produce a defect in the contour For all these conditions except the syphilitic nose the treatment *par excellence* is the insertion of a new nasal bridge. In a previous edition it was stated that a hinged costal-cartilage graft was the method of choice As will be observed from the notes on cartilage and bone-grafting it has been abundantly proved that many cartilage grafts undergo subsequent bending and that none of the defects of cartilage grafts are evident with bone-grafting The operation of choice therefore is that of super imposing above the existing nasal arch an adequate rod of bone from the iliac crest shaped to meet the needs of the individual case As in the majority of cases bony union actually occurs between the bone graft and the nasal bones the support to the tip is quite adequate without the addition of a hinged columellar support This simplifies the operation and therefore the skin incision need only be made vertically through the skin of the columella. This gives a direct approach and makes the incision very easy to suture afterwards The method of taking the bone graft from the crest of the ilium has already been mentioned and is quite straightforward Considerable thought should be given to the exact shape of the bone-graft for the individual case

Pre-operative preparation.—The nose is prepared for the operation



Fig 828.—Partial destruction of nose following lupus. Rhinoplasty by forehead flap based on the superficial temporal artery Photograph shows how readily all scarring is hidden by suitable dressing of the hair
(Gillies Plastic Surgery of the Face)

Depressed fracture of the nose.—One of the most common accidents both on and off the road is depressed or lateral-displaced fracture of the nasal bridge. This type of injury shows little or no loss of the supporting structures. If the case is seen any time in the first three weeks after the accident the nasal arch can usually be manipulated into normal position. Too much emphasis cannot be laid on the necessity of giving the patient general narcosis. Using Walsham's forceps for the sides of the arch and Ash's forceps for the septum both the dislocation of the latter and the impaction and displacement of the nasal bones can be rectified and septum and bones manipulated into position. It is well to fit over the replaced nose a small mould of dental composition over which a piece of malleable lead plate is fixed. A satisfactory splint can also be made from plaster of Paris bandage. A 4 in. Cellona bandage is folded upon itself in 6 in. lengths ten times. From this is cut a pattern which accurately fits over the nose, continues up over the glabellar region and spreads out as two wings, one on each side of the forehead to the temporal hair line. The eyebrows are greased and the splint applied and allowed to set. It is held in position by two tapes tied round the head, one across the forehead and one across the nasal bridge. This should be worn for two or three days to prevent excessive swelling and to maintain the position.

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Pre-operative preparation.—The nose is prepared for the operation

by cutting short all hairs to be found in the skin of the vestibule. After careful removal of all crusts the nares are packed on the evening before operation with small plugs of wool or gauze soaked in flavine

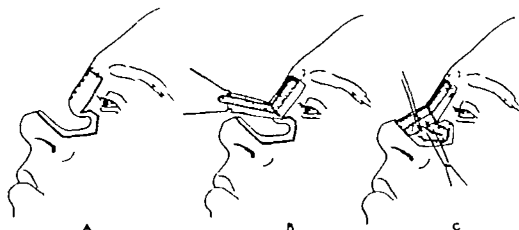


Fig 829 —Central defect of nose.

A, implantation of small rod of cartilage B, C, details of formation of lining membrane of missing portion by inverting side flaps.

solution At the time of operation the nares are again carefully and gently swabbed out with small pledgets of gauze soaked in ether They are then wiped over with surgical spirit.

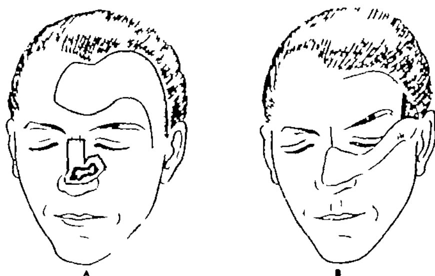


Fig 830

A, cartilage rod turned down with the upper flap. B, outside defect covered by curved temporal artery pedicle flap.

Operative technique.—The columella is grasped between the finger and thumb and a small bladed No 15 Bard Parker knife makes the incision in the midline separating the two mesial crura of the alar cartilages The two layers of the septum are carefully divided until the superficial aspect of the bone is reached when the periosteum is

elevated or removed by small rugines and a pocket made in the glabellar region underneath the periosteum (Figs 829 and 830) The surface of the bone has now to be filed or chiselled in order to expose some of the medullary portion and to make a good platform on which the bone-graft can sit The bone-graft, having been obtained from the iliac crest is now inserted and the wound closed. The length of the bone-graft will usually need to be about 1¾ in and it must be very thin where it overlies the nasal bones and thicker

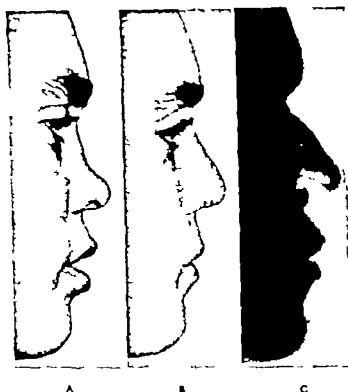


Fig 831

A, impacted depressed fracture of nasal bones. B result of insertion of iliac bone graft. C, X-ray showing bony union.

opposite the deepest part of the depression It should then tail off into a thin strip towards the tip of the nose and should not be carried to the extremity X ray and photographs of a bone-graft which united with the nasal bones are shown in Fig 831

Syphilitic nose —Care must be taken not to confuse the deformity caused by syphilitic ulceration with that of an ordinary depressed nasal bridge The difference lies in the recognition of the tissue lost In syphilitic nasal conditions there is a concomitant loss of mucous membrane as well as of bone and cartilage consequently if the surgeon is tempted to insert a bone-graft only the result will be extremely disappointing Provision must be made for the missing mucous membrane The real loss is not apparent until the skin and soft tissues of the tip have been freed from their vicious attachment

to the maxilla Thus an incision is made in the upper buccal sulcus deepened until the nasal cavity is penetrated and carried on laterally on each side as far as the glabella Then the whole shape of the nose becomes apparent as there is no loss (normally) of the external skin. On further examination a large raw area will be found on the under surface of the skin and lateral portions of the nose. This must be skin grafted by the dental-splint pressure method already described The skin-graft must be maintained at full stretch for three months when the dental appliance may be discarded and a bone or cartilage

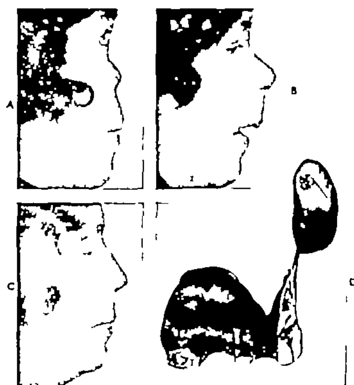


Fig 832
A, specific ulceration of nasal mucous membrane B, preliminary overdistention. C, result of treatment by skin inlay D permanent dental prosthesis by Mr F A. Walker London.

graft inserted in the bridge-line between the external skin and the newly implanted internal skin graft This operation is a most dramatic and successful procedure. Alternatively the temporary dental appliance may be modified by the dental surgeon and used by the patient as a permanent support in which case only one operation is needed (Fig 882) Full details of the treatment of this defect can be read in papers already published *

PLASTIC OPERATIONS ON EYELIDS AND EYEBROWS

In cases in which the whole of an eyelid has been destroyed the result of any plastic operation is likely to be far from pleasing for

* Deformities of the Syphilitic Nose *B M Med Journ* Nov 1923, ii, 977 and *Dtsch Z Chir* Feb 22, 1926, cci, 379

almost invariably the new lid which can be made remains thick heavy and lifeless in appearance. When however the loss of the lid-edge is limited to one-third or less of the whole a very satisfactory repair can be made

The operations described in this section apply only to cases in which the eye itself has been lost for it is seldom that the surgeon will be

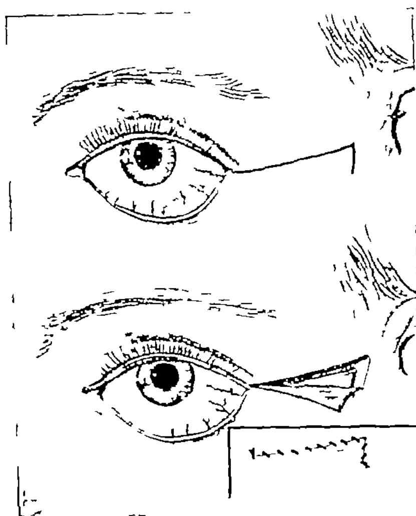


Fig. 833 —Reconstruction of lower eyelid first stage.

Above incision for implantation of thin flak of cartilage. Below flap undercut and cartilage implanted. Inset, flap returned over cartilage implant.

called upon to reconstruct an eyelid where a normal eye remains Here again the principle of *restoration in kind* must be emphasized

Figs 833 and 834 illustrate a typical reconstruction of the lower lid The operation is divided into two stages (1) Cartilage from the ear or from the ribs of a suitable length and thickness is inserted subcutaneously beneath the site of the proposed flap extending outwards from the external canthus After a minimum period of ten days a combined skin cartilage flap is raised and swung inwards the skin forming the lining of the new lower lid and the cartilage now lying on

and being adherent to its anterior aspect. The lower border of the skin is carefully sutured to the upper edge of an incision made along the lower margin of the conjunctival remains and in this way a new lower fornix is completed (2) The raw surface now remaining may be dealt with in one of the following ways —

(a) The outer part of the wound may be closed by approxima tion and the lid portion Thiersch or Wolfe-grafted

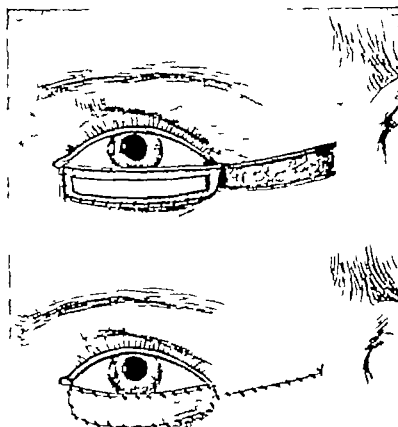


Fig 834.—Reconstruction of lower eyelid second stage.

Above, cartilage-bearing flap sutured for lining of new lid. Below area from which inturned flap has been taken closed by approximation. Covering skin for eyelid obtained by free skin-graft (Wolfe variety).

(b) A descending temporal flap may be swung down to cover both defects

(c) A flap may be brought up from the cheek.

(d) A double pedicled flap may be taken from the upper lid (Tripier) (Fig 885)

(e) Skin may be conveyed to the lid by a tubed pedicle from the neck.

When a live eye is present mucous membrane must be on that portion of the reconstructed lid that will be in contact with the globe. If any skin is used minute hairs will grow and irritate the eye

Eyebrows may be provided by transposed temporal artery scalp-flaps The extremity of the flap should be composed of a curved piece of skin of suitable length and having the hairs growing in the correct direction A much more satisfactory way is to cut a thin curved strip from the scalp in the mastoid region of the same side and

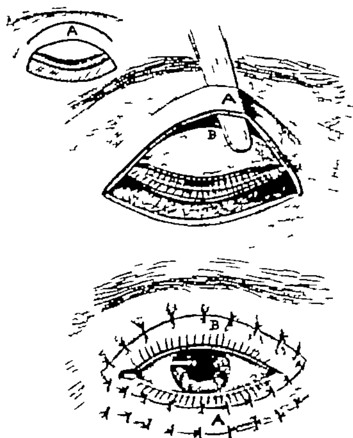


Fig 835.—Reconstruction of lower eyelid by double pedicled flap from upper eyelid. (*Tripier*)

to sew this hairy graft in to form an eyebrow Not all the hair follicles survive (Fig 836)

Temporal Muscle Swings

In those cases of injury in the vicinity of the eye in which the chief disfigurement is due to the loss of prominence in the malar and infraorbital regions the temporal muscle swing operation has proved of great service

After excision of scars and general re-arrangement of skin in the flattened area a U-shaped flap is turned down from the temporal region and the temporal muscle exposed. The anterior one-third to one half of the muscle together with its overlying fascia is detached from its origin and freed well down towards the coronoid process of the mandible. The fascial attachment to the remains of the zygoma must also be carefully divided.

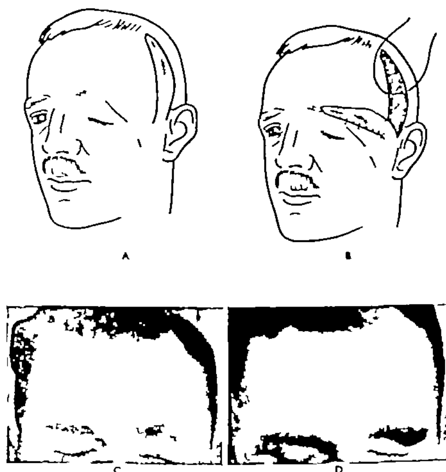


Fig 836

A, B pedicle graft method of making eyebrow. C, D hairbearing dissected graft. C, before operation. D after operation.

The free extremity of the muscular flap thus fashioned is passed under the bridge of skin separating the two operation areas and given a new origin in the region of the upper part of the maxilla where it is anchored by deep sutures to the periosteum. The blood and nerve supply are not apparently seriously interfered with for in the majority of cases the transplanted muscle can be made to contract and gives a very colourable imitation of the action of the orbicularis oculi which is usually paralysed from the associated upper facial paralysis.*

* Details of this operation will be found in *St. Bartholomew's Hosp. Journ.*, May 1917 xxiv 80. *See also* p 1957

Artery Pedicle Flaps

In selected cases an island flap of skin and subcutaneous tissue can be moved on a pedicle containing only the main vessels supplying it

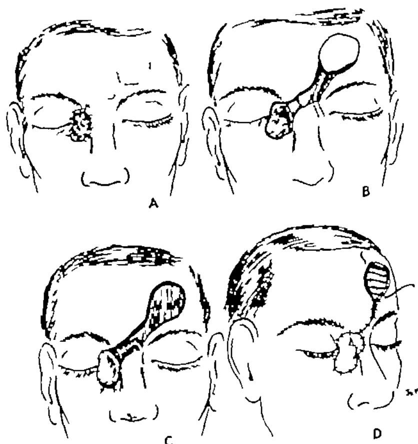


Fig 837 —A supratrochlear artery pedicle flap for replacement of defect after excision of rodent ulcer



Fig. 838 —Rodent ulcer A, before operation. B operation completed.

This technique is useful for the replacement of small defects about the eyes and nose and the available arteries are the superficial temporal

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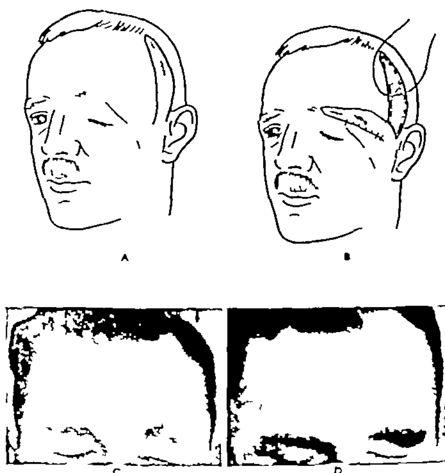


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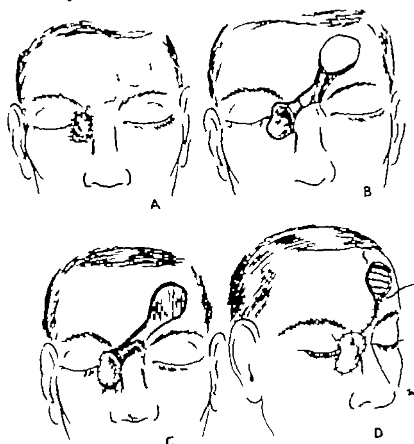


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Fig 838 —Rodent ulcer A, before operation. B operation completed.

This technique is useful for the replacement of small defects about the eyes and nose and the available arteries are the superficial temporal

the supraorbital and the subtrochlear Its advantage is that it is a one-stage repair but a careful atraumatic dissection is necessary if thrombosis is to be avoided

Cicatricial Ectropion*

This disfiguring disability the most important and constant sequela of facial burns has shown itself particularly amenable to treatment by the procedure known as the epithelial outlay based on the Esser skin-graft

An incision is made immediately external to the ciliary margin and extending completely across the area involved usually from canthus

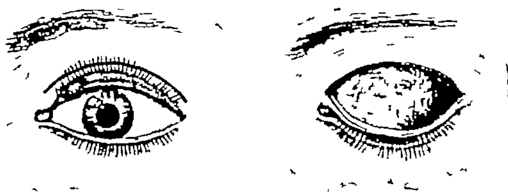


Fig. 839 —Operation for cicatricial ectropion.

Above, incision from canthus to canthus freeing lid margin. Below lid margin brought into over-corrected position by dividing all scar tissue bands.

to canthus Gentle traction on the lid margin being maintained the incision is gradually deepened until the lid edge can be brought into an over-corrected position The musculature of the eyelid should be damaged as little as possible A small mould of dental modelling composition is made of such a size and shape as to lie snugly in the raw surface and allow the skin-edges to be approximated over it A small thin hairless Thiersch graft taken usually from the arm is wrapped round the mould in such a way that its two free edges meet on the anterior aspect The graft-covered mould is placed in position on the raw surface and horsehair stitches are passed from skin-edge to skin-edge picking up the free edges of the graft on either side The mould is thus buried and the ectropion is reproduced and may be even exaggerated for the time being The after treatment consists in keeping the eye clean by frequent irrigation and removing crusts from the wound Nothing further is done for ten days when any sutures which have not already cut out are divided and the mould is discarded. The eyelid now falls into a normal position and its outer surface is invariably found to be completely epithelialized From this

* See also p. 1577

time onwards the cosmetic result rapidly improves the somewhat hollow appearance following the removal of the mould becoming smoothed out in a comparatively short time Gentle daily massage after the application of a little sterile liquid paraffin expedites the latter process Rarely a certain amount of minor trimming at the margins of the graft is required Figs 839–40 illustrate the various stages of this operation

Although this buried method of applying the graft is a very definite and pleasing process the method is now generally modified by

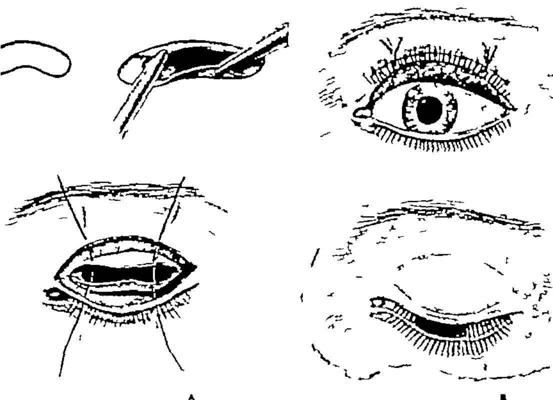


Fig 840 —Operation for cicatricial ectropion.

A Above, mould of dental composition. Thiersch graft being wrapped around mould. Below mould and graft in position, showing main sutures piercing graft and margins of raw surface.
B Above mould and graft completely buried. Below result of grafting

applying the mould superficially without any stitching The graft is applied to that part of the mould in apposition to the raw area and the mould and graft are fixed by suitable dressings (*see* Skin-grafting p 1952) Occasional stitches are used to unite temporarily the upper and lower ciliary margins and prevent lid movement.

This modification is easier to perform and gives quite perfect results almost from the start The graft need not be cut especially thin

Wolfe graft for cicatricial ectropion.—In minor degrees of ectropion a free graft of eyelid skin from the opposite upper lid gives a most perfect result The whole-thickness skin is used and sutured into

place according to the principles outlined under the section for Wolfe grafts (p 1054) In larger defects an excellent graft for the lids is obtained from the skin on the back of the ear This is usually of good colour and flexible The suture of the skin at the back of the ear gives little trouble the posterior margin should be undermined The best stitch for the skin-edges is a subcuticular one which is put in while the ear is held forward and when every bite for the stitch has been taken the whole is gradually tightened There is no doubt that the successful Wolfe graft gives a better cosmetic and as good a functional result as the split-skin graft particularly in the lower lid.

PLASTIC OPERATIONS ON THE EARS

Perforations of the pinna may be closed by small flaps swung from the posterior surface and covered by skin grafts

Marginal losses, producing a much more noticeable disfigurement are best treated by turning up flaps from the posterior aspect of the pinna containing previously implanted cartilage Such cartilage may be obtained from the same pinna or that of the opposite side where its removal appears to cause no disfigurement or it may be taken from the costal region in the usual way and fashioned to the required shape and size The covering for such a cartilage-bearing flap may be obtained by skin-grafting or by a small tubed pedicle or bridged flap from the neighbouring part of the neck.

More extensive losses are treated by implantation of suitably shaped cartilage beneath the skin of the mastoid region and later by turning this supported flap forward into a normal position and covering its raw surface with skin-graft or skin flap

Congenital absence of the external ear —So far as treatment is concerned this might be classed with extensive traumatic loss and owing to the advent of the new method it can be treated by surgery The principle upon which this repair is established is that it has been found possible to graft ear cartilage from a donor usually the mother or other female into the non hairy portion of skin in the neighbourhood of the missing ear usually behind it The maternal ear-cartilage is grafted as the first stage after the skin has been superficially undermined At the end of three months all the shapes and hollows of the maternal ear will be showing through the skin under which it has been placed (Fig 841) An incision is then made round the circumference of this implanted cartilage which is turned forward into the position of the new ear together with its skin covering The raw surface so caused comprises that on the posterior part whence the flap has come and the posterior surface of the new ear itself This is either skin-grafted direct or repaired by a tubed pedicle flap previously prepared from the acromiopectoral region This method has made a complete

revolution in the principles and results of making a new external auricle *

Adhesions of pinna—Cases in which the disfigurement consists entirely of adhesion of part or all of the pinna to the mastoid region a frequent sequela of severe burns may be treated by freeing the pinna and Thiersch grafting the raw surfaces of the pinna and mastoid region by grafts applied on a suitable mould

Prominent ears.—In most cases prominent ears are due to faulty formation of the antihelix Normally this cartilaginous fold holds the scapha and with it the rim of the helix back towards the side of

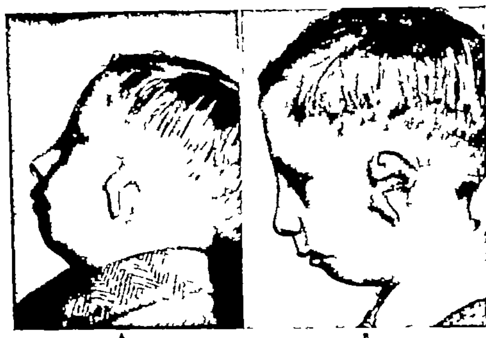


Fig 841
A, congenital absence of external ear B same case after grafting of maternal ear cartilage before final plastic which consists of joining the lobule turning the new ear forward and skin grafting the posterior aspect

the head Of secondary importance is the occasional over-development of the concha and both factors are taken into consideration in planning treatment

Luckett s operation forms the basis of modern technique and after a post auricular ellipse of skin has been removed the cartilage is incised along the line of the antihelix and its crura care being taken not to perforate the anterior skin The concha may be reduced at this stage if necessary The cartilage is folded back upon itself and held by a series of catgut or silk sutures and the post auricular wound is closed. A careful pressure dressing is essential to avoid hæmatoma it remains *in situ* for seven days and thereafter a protective bandage is worn at night only for a month †

* Gillies Reconstruction of the External Ear with Special Reference to the use of Maternal Ear Cartilage as the Supporting Structure *Rev Chir Structive* Oct 1937 N 3 iii, 169

† Luckett, W H (1910) Surg Gynec Obst x, 635 Joyes, P H, and Dale R, H (1951) *Br J Plast Surg* 193





Fig. 842.—Complete loss of upper lip treated by turning in, from the immediate neighbourhood of the defect, skin flaps for lining and mucosal flaps for vermilion border. The covering skin was provided by ascending flaps from the lateral aspects of the chin. (Gillies' "Plastic Surgery of the Face.")

PLASTIC OPERATIONS ON THE LIPS

Repairs of the **upper lip** call for the provision of skin-covering muscular and subcutaneous tissue mucous-membrane lining and vermilion border In the male subject it is better if at all possible to provide a skin-covering which shall be hair bearing

The methods advocated are six

1 **A single or bilateral ascending flap of full thickness** (i e composed of skin subcutaneous tissue muscle and mucosa) —Such a flap in the male is hair bearing and though much of its blood supply must be destroyed by the division of several of the main branches of the facial artery its vitality has usually proved satisfactory It is particularly apt to produce a depression of the angle of the mouth requiring a secondary operation for its correction but on the whole the results are satisfactory

2 **Descending flaps from the lateral nasal region.**—These again may be made of full thickness in part of their extent but they have the disadvantages that their length is naturally limited and that they bear no hair In their favour however are the facts that they contain well marked branches of the facial artery and hence have a particularly good blood supply and that they have not the same tendency as the flaps in the first method to produce depression of the angle of the mouth

3 **A hair-bearing flap brought down from the forehead or temporal region on a tubed temporal-artery pedicle.**—In this method the lining must be obtained from the immediate neighbourhood of the defect either by turning in skin flaps or by swinging mucosal flaps from the inside of the mouth Fig 842 illustrates a case in which the latter part of this procedure was carried out the covering flaps however being obtained from the chin In cases where hair bearing skin is not required both lining and covering may be brought from a more distant part of the body where subsequent scarring may be easily hidden by means of the tubed pedicle flap

In all cases it is necessary to guard against providing a lip deficient in length from side to side for the disfigurement produced by such a flattened or tightened upper lip is very serious

4 **Advancement flaps.**—For minor losses simple advancement operations or the combination of local flaps and skin grafts may suffice Vermilion margin is best obtained from the opposing lip or cheek For the transfer of mucosal vermilion border from upper to lower lip a small flap is turned down and stitched in position on the surface prepared to receive it. The lips are fastened together in such a way as to allow space for feeding the patient and after a period of ten days the bridge is divided and the mucosa re-arranged on both lips. It is surprising how little the lip which may be called the donor suffers in this procedure by the loss of quite a considerable flap For larger whole

thickness losses of both upper and lower lips the fan flap is available for an immediate repair following excision of trauma of not more than ¼ to ⅓ of one of the lips Natural looking with some good movement the new mouth is slightly contracted at the corner and may require later widening

5 **Abbé's operation** consists of taking a triangular whole thickness wedge out of the lower lip to fit when turned upside down into a gap in the upper lip It is kept alive on one coronary vessel and a tiny pedicle The results are strikingly good and give a pleasant everted upper lip This operation is especially applicable to severe double hare-lip cases

6 **Fan flaps** are developments of the Abbé principle but turn round one or other corner of the mouth

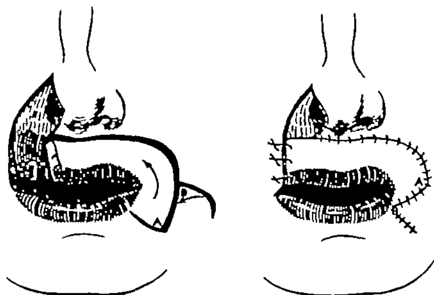


Fig 843.—Diagrammatic representation of the fan flap.

Small losses in the **lower lip,** not extending to more than one-third of the whole may be repaired by simple advancement methods requiring no special description (Fig 845)

More extensive losses may be made good by descending full thickness flaps by ascending inframandibular flaps of the vertical-to-horizontal type or by tubed pedicle flaps from a more distant part of the body In the very extensive losses affecting the whole of the chin region the lining membrane is usually obtained by in turned flaps from the margins of the defect These usually carry hair follicles and the growth of hair into the mouth may prove troublesome It must be remembered however that it is easy to get rid of this trouble at a later stage by Thiersch grafting when the tissues of the new chin have become established.

For very large losses the forehead skin swung down on both temporal arteries makes a very satisfactory covering. Later on it is possible to reconstitute the bony framework of the chin replacing the missing portion by a suitably shaped bone-graft from the iliac crest or the

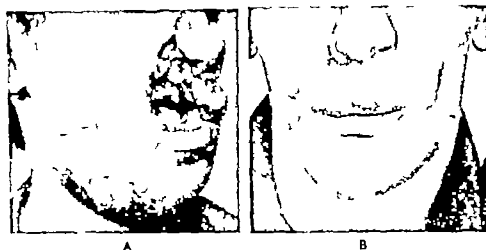


Fig 844.—A, lip defect suitable for fan flap and, B the result.
(Photographs by kind permission of Dr James Cuthbert)

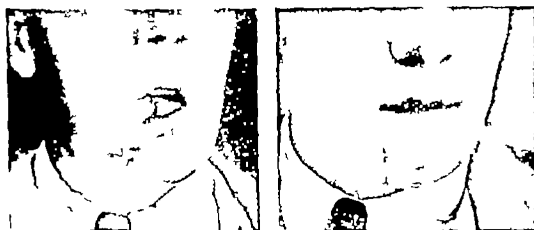


Fig. 845.—Repair of loss in lower lip and chin by simple advancement flaps, swung upwards in V Y fashion, after excision of all scar tissue
(Gillies "Plastic Surgery of the Face")

tibia. An osteo-periosteal graft obtained from the tibia may be curved to a nicety and is therefore particularly useful

In plastic operations in the region of the lips except where repair can be carried out by local musculo-cutaneous flaps it is difficult to avoid producing thick lifeless-looking masses which give a poor cosmetic result and add very little to functional efficiency. It should be added that the previous preparation of a suitable prosthesis is of the greatest help in all these cases in that it provides a scaffolding over which the new tissues may be built

HARE LIP* OPERATIONS FOR THE CORRECTION OF SECONDARY DEFORMITIES

The object of operations for hare-lip is the removal of the cleft lip stigma The surgeon should only be satisfied when the lip and nose reveal no sign even of good repair The observer should think no more of the patient s lip than that there had been a slight accident to it some time (Fig 846) But the original deformities of the nose and lip are often so complex that it is unreasonable to expect any one operation undertaken as it is at a very early age to accomplish more than an



Fig 846

A, hare-lip at six months of age B same case three years and ten months old. C, Same case seventeen years old.

aseptic closure with simple adjustment. This produces a sound basis for future cosmetic work and the surgeon should be able to employ other procedures such as have been recently described by Gillies and Kilner in order to free his patient from any vestige of hare-lip stigma

These operations are directed towards —

(a) The readjustment of general contour
(b) The readjustment of the lip
(c) The readjustment of the nose

General contour —The commonest contour deformity seen in old hare-lip and cleft palate cases is produced by flatness of the lip and depression of the nose. It is obvious that the flat lip is caused by a lack of forward projection in the underlying maxilla most marked when the premaxilla has been removed but present in a lesser degree in a large proportion of lips which have been constructed over complete alveolar clefts either bi or uni lateral.

* See also Chap. xxxiv p. 1818.

The operative procedure most widely applicable to this type of lip and nose has been called the buccal inlay and consists of the introduction of a Thiersch graft on a mould designed to free the lip and nose from the underlying retroposed maxillæ Freeing and loosening the lip in this way allows an upper denture sufficiently prominent to produce normal contour and carrying well in advance of the existing position artificial teeth which articulate normally with the lower teeth

Technique of buccal inlay—The dental appliance is prepared beforehand and should consist of a simple metal cap splint fixed to the existing teeth and carrying a small adjustable tray in front to support



Fig 847 —Buccal inlay showing resultant change of contour
Reproduced by permission of *The Lancet*.

the moulding material used to build forward the lip and carry the Thiersch graft.

General anæsthesia by the intratracheal method of Magill is used and the pharynx is packed off so that there is no communication between the upper air passages and the field of operation. An incision is made along the upper buccal sulcus penetrating the nasal cavity and is carried laterally over the surface of the maxilla on each side to a greater or lesser extent according to the backward displacement of the nose. The extent of lateral undermining depends on the degree of nasal displacement. As the tip of the nose is usually dragged down and back scissors are passed through the mouth incision and with one blade in each nostril the membranous part of the septum is progressively divided until the nose tip comes forward and upward to the desired position. Next a piece of Stent s modelling compound steeped in boiling water is taken and moulded between the lip and the nose in front and the maxilla behind care being taken to prevent any excess passing into the nasal airways The tray of the splint is

fitted and the mould adjusted to it and manipulated to produce an exaggerated edition of the desired contour The mould is set by dripping iced water over the parts and is then removed with the tray After being dried it is held by an assistant to receive raw surface outwards the Thiersch graft previously cut from a non hairy part of the body When the one-piece graft has been stretched evenly over those parts of the mould which come into contact with raw surfaces, the whole contrivance graft mould and tray is pushed back into position and the operation terminated by tightening the screw which holds the tray to the splint Fixation of the upper lip by mastisol strapping is advisable though not strictly necessary

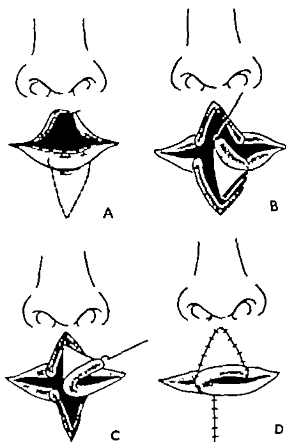


Fig 848 —Detail of Abbé operation, first stage. The second stage consists of simple division of the mucosal bridge.

The nose and mouth are kept clean and the mould is removed in about a week to ten days when the graft is found perfectly adherent to all raw surfaces Excess of graft is mopped or irrigated away and the tray and mould are cleaned and replaced for another ten days. The patient is then handed over to the dental surgeon who replaces the mould by a new one of black gutta percha. This new mould is removed daily at first for cleansing purposes and later is cared for like an ordinary denture. Finally the dentist fits a comparatively simple upper denture hiding the malplaced upper teeth, blocking the oro nasal communication but leaving the nasal airways free pushing forward the lip and nose-base and bearing teeth occluding normally with the lower ones. Fig 847 shows the result of this simple procedure.

Re-adjustment of the lip.—Several problems present themselves in dealing with the lip These are concerned with the malposition of the prolabium producing depression of the tip of the nose, the lip scar itself and the lip margin.

One of the commonest cosmetic faults is found in cases of double hare-lip for the so-called prolabium is often placed so far down the

lip that the lobule of the nose is dragged down with it The prolabium varies greatly in size and only when it is fully developed can it be considered truly part of the lip and vermilion border In most cases it represents the base of the columella only or a lateral continuation of the skin of the sides of the columella into the floor of the nares The mucous membrane of the premaxilla having failed to unite with that of the advancing lateral processes forms a pseudo-vermilion border for the prolabium and this has tempted many a surgeon to utilize it in the construction of the new lip-margin to the permanent detriment of the patient



Fig 849—A, severe upper lip defect. B result of Abbé's operation.

It is imperative in all cases of down-drawn nose-tip to take the prolabial skin out of the lip and suture it so high upon the free border of the septum as will allow the nose to come forwards and upwards into normal position. To ensure this it may be necessary to divide the membranous septum with scissors which are carried over the anterior border of the septum in order to free the parts sufficiently The membranous septum is reconstructed later with sutures which maintain the corrected and advanced position of the columella and nose tip Following the removal of the prolabium from the lip there remains a V-shaped gap The skin of the lip the floor of the vestibule and the base of the alæ are carefully undermined by a blunt-ended knife This loosens the false attachments of the alæ and a buried catgut suture is inserted to gather the deep tissue together and support the columella from below and behind. This stitch draws in the alar bases and so improves the nose still further by narrowing the nostrils at the same time it reduces tension on the scar which results from the approximation of the margins of the skin defect Often it is far better to combine this repair with an Abbé flap from the lower lip (Figs 848 849)

Little need be said about the lip scar except to emphasize the necessity for removal of all scar tissues accurate apposition and

resuture of the muscle bundles and careful equalization and apposition of skin and mucous membrane. The well known Rose type of repair is to be preferred to any system of complicated flaps or incisions. To obtain a high standard of cosmesis the greatest care must be taken to avoid tissue tension and trauma and all manipulations





Fig 850A.—Before operation (above) and after operation (below) illustrating the formation of Cupid s bow

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must be carried out with a light touch. Eyeless needles mounted on the finest ophthalmic silkworm gut tiny hooks rather than forceps and sharp knives are necessary to attain these standards

Even when the skin edges have been accurately sutured general asymmetry of the lip margin may remain On the other hand the lip itself may be too long vertically for its length from side to side with very little vermilion border showing and resembling somewhat the lip of an Irishman s caricature. In both instances a pleasing result may be obtained by performing the Cupid s bow operation In principle this consists in discarding altogether the existing skin-vermillion junction and making a new curved lip border at a higher level. At the same time the lower band of muscle should be nicked on each side of the philtrum The result is an attractive short lip with a full mucous membrane and at least a suggestion of a Cupid's bow (Fig 850) It should be realized that apart from the cosmetic

improvement obtained by the operation the closure of the two elliptical or diamond shaped defects produced by the excision has the effect of increasing the side-to-side dimensions of the lip margin much as the Rose-type closure of a lip-cleft increases the vertical dimensions of the lip In many double cleft lips there has been so much surgical and developmental loss of tissue that nothing short of grafting a whole thickness flap from the lower lip (Abbé s operation p 1996) is likely to give any striking improvement

Re-adjustment of the nose.—The relation of the depressed nose to the prolabium and the treatment of this deformity has already been discussed In addition however there is frequently separation of the intercrural angles of the alar cartilages producing excessive width of the lobule of the nose. Correction can usually be obtained



Fig 850B.—Example of the correction of crooked nose and flat ala. Note Cupid s bow
Reproduced by permission of *The Lancet*.

by carrying out the procedure already mentioned in which the incisions separating the prolabial skin from the lip are carried forwards on the membranous septum freeing the mesial crura and allowing them to slide forward on the free border of the nasal septum to re-form the tip of the nose. (Fig 850) In more severe cases it is necessary to carry these incisions still further to free also the intercrural angles and the anterior parts of the lateral crura. In some cases there is insufficient septal development to give prominence to the new tip and a supporting graft of cartilage or bone is required later

The most difficult problem and one which has proved a stumbling block to all surgeons is undoubtedly the correction of the flat ala. Since the structural defects underlying the deformity are gradually being made clear however the hope is expressed that the difficulty can be satisfactorily overcome and the nostrils made to appear symmetrical. The factors contributing to the production of this complicated deformity when carefully analysed include the following

(a) Deviation of the septum away from the flattened ala combined with lack of support to the alar cartilage due to this tilting

(b) Maxillary under-development The poor development of the smaller maxillary element results in an outward and backward drag of the ala on that side

(*c*) Secondary distortions of the alar cartilages The treatment of this complex deformity is difficult to standardize and each case must be judged on its merits

Treatment.—A suitable choice of one or more of the following manœuvres is recommended —

Straightening the nose —The whole nose may be mobilized and set straight by osteotomy of the frontal processes of the maxillæ and of the nasal bones themselves where they articulate with the frontal bone followed by freeing the septum from the nasal crest and spine of the maxilla The freeing of the septum in its anterior part may usually be done submucously but occasionally it is necessary to divide all its layers and displace it bodily before it can be persuaded to lie in the middle line In severe cases of lateral deviation of the nose, the long side of the bony arch—that on the side of the smaller lip element—requires reduction by the removal of a wedge if this is not done a gap is left in the arch on the short side in the line of osteotomy when the nose has been re-set and there is a natural tendency for the nose to become deviated again by the approximation of the edges of this defect

Replacing the alar cartilage —The distorted alar cartilage must be mobilized to allow it to slide forward into symmetry with its fellow and it must be fixed in this new position by suture When the distortion is mild in degree the incision may be entirely intranasal, i.e confined to the skin of the vestibule and the membranous septum. The whole of the convex surface of the cartilage (that aspect of the cartilage furthest from the vestibule) is undermined when it will be found that the depressed ala spontaneously tends to assume a normal position.

In some cases it is necessary to carry the undermining well over to the other side of the tip to provide room for the new intercrural angle to lie in contact with its fellow and sit correctly over the end of the septum In this position it is fixed by a mattress-suture passing through the anterior parts of both mesial crura.* In severe cases an incision must be made in the middle of the columella separating one mesial crus from the other and carried forwards into the tip of the nose curving towards the normal side It is sometimes necessary to prolong the incision backwards carrying it round the out turned extremity of the mesial crus and coming out into the vestibule. In all cases the intranasal incision already described for milder cases must be made in addition The mesial crus having thus been freed is slid forwards into correct position and held there by skin sutures in addition to the mattress-suture described The sliding forward of the half-columella in this manner in unilateral cases is comparable with the sliding forward of the whole columella in bilateral cases. (Figs 851 852) By these steps the intercrural angles are rendered symmetrical and the tip of the nose is made normal in appearance.

* A. H. McIndoe Correction of Alar Deformity in Cleft Lip, *Lancet*, Mar 12, 1938, i, 607

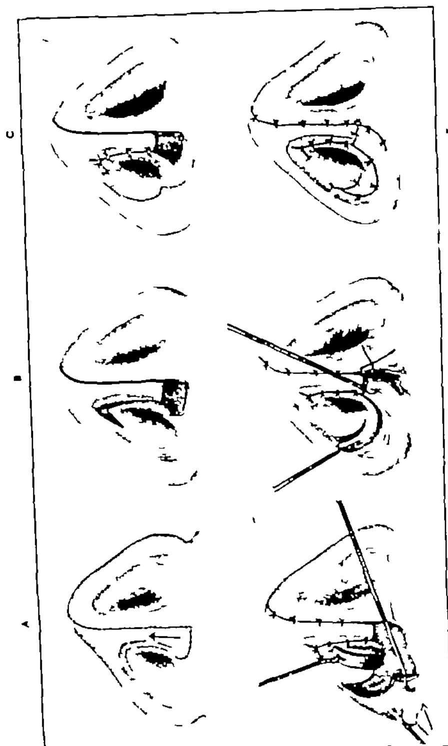


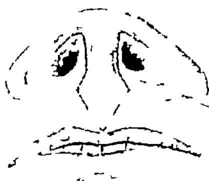
Fig 851 —Operation for flat ala (severe) A, First incision to advance the half columella. B Half-columella advanced. C Secondary incisions to free alar base and to raise small triangular flap from floor of nostril. D Flap raised alar base freed. E, Flap transposed. F Final suture. Reproduced by permission of *The Lancet*.

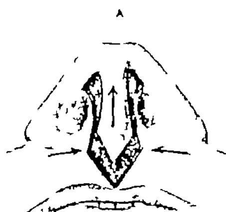
To sum up it is unlikely that all these procedures will be required in any one case but in order to remove the hare-lip stigma the surgeon should be prepared to advise a group of them selected in accordance with the deformity e g —

Flat contour depressed tip wide nostrils

1 Buccal inlay and provision of special prosthesis

2 Plastic operation to re form nose-tip and narrow nostrils
8 Cupid s bow operation on the lip margin





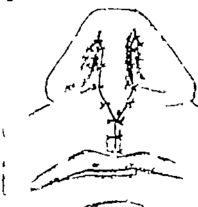


Fig 852 —A, incision for flat tip (bilateral) B, advancement of tip. C, suture

4 Cartilage or bone graft to nose bridge

These may with good technique, be combined into two operative stages.

Flat ala crooked nose irregular lip margin and bad lip scar

1 Osteotomy of nasal bones and straightening of nose

2. Alar plastic.

8 Muscle re-suture and Cupid s bow operation

In most cases it is advisable to leave the Cupid s bow operation as a final *pièce de résistance* until after the lip scar has received attention and the muscle layer has been sutured *

BUCCAL INLAY IN THE RESTORATION OF UNDER DEVELOPMENT OF THE CHIN

These patients present a deformity that is depressing both to themselves and to their parents. It can be relieved to an amazing extent by the operative technique of the buccal inlay (Fig 858) The details are precisely similar to those already described for the retroposed upper lip in hare-lip deformities. An incision is made in the lower buccal sulcus from premolar to premolar and deepened with a knife not a rugine until the soft tissues of the chin can be brought well away from the mandible. The whole of this raw surface is now skin-grafted by using a mould held in position by a dental

* Previous references to the use of the buccal inlay in hare-lip and cleft-palate surgery are to be found in the following papers —H. D. Gillies and W. Kelsey Fry, "A New Principle in the Surgical Treatment of Congenital Cleft Palate and its Mechanical Counterpart," *Brit Med. Journ* 1921 i, 335. T P Kilner and T Jackson, "Skin grafting in the Buccal Cavity" *Brit. Journ. Surg* 1921 ix, 148. H D Gillies and T P Kilner "Hare-lip Operations for the Correction of Secondary deformities, *Lancet*, Dec. 24 1932, ii, 1369.

appliance. It is not uncommon for certain parts of the cavity particularly over the prominence of the bone to show small areas of necrosis in the skin graft These must be treated carefully until the whole has epithelialized At no time must the cavity be left without the dental mould until the time has arrived when the skin graft ceases to contract This may be some two to three months after operation These skin-grafted cavities appear to stand up well to wear and tear but occasionally the pressure of the appliance has unduly exposed the neck of a tooth in the early stages of restoration

Orthodontic methods of correcting the lower teeth do not appear to have any satisfactory result in producing a prominence of the chin merely bringing the teeth into line without affecting the bone A good cosmetic chin can be made by bone-grafting but this requires an external incision and is not in my opinion so accurate in effect as the method described

This inlay operation is also of value in edentulous cases in which



Fig 853.—A, bird face deformity B, result of treatment by buccal inlay and creation into epithelial pouch into which shaped dental prosthesis is placed.

Dental work by Mr E. A. Hardy London.

a full lower plate has to be fitted on an inadequate sloping ridge. The inlay is designed with the express purpose of assisting the dental surgeon to obtain a good grip on the mandible for his plate.

CLEFT PALATE

Such a notable advance in the technique of cleft palate work has occurred since the first edition of this work that this section has now been entrusted to one of the chief leaders in this subject (Chap XXXIV Wardill p 1919) This satisfactory state of affairs appears to me to follow a volume of work and thought in many countries. A typical palate restoration may now be described as consisting of the Veau closure of the nasal mucosa long lateral incisions (Addison)

fracture of the hamular processes and extensive freeing from the lateral pharyngeal wall Wardill s pharyngoplasty and some form of palatine flap operation Veau the four flap or VY advancement. Although normal speech can now be expected as the rule rather than the exception there are cases especially of the secondary variety in which there has been loss of tissue or a gross failure to develop in

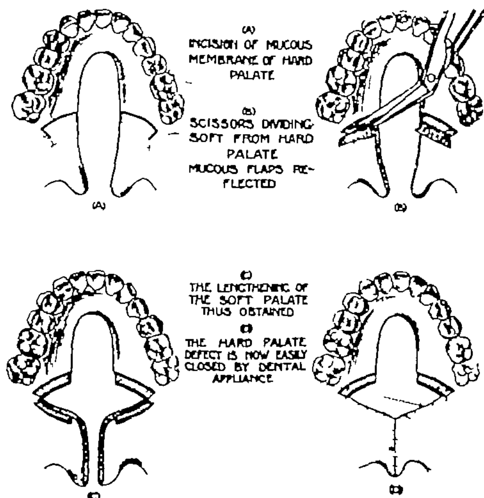


Fig. 854.—Diagrams illustrating the Gillies-Fry method of closing cleft of hard palate and of reconstructing efficient soft palate by combined operative and mechanical means. (Closure of the hard palate (D) can also be effected by tube-pedicle insert.)

which the partial repair—the Gillies-Fry operation—is still indicated Roughly speaking this consists of separating the soft palate from the hard and freeing each lateral wall until they fall into position with the pharyngeal constrictor The raw edges and surfaces thus produced must be covered by some form of epithelium either a flap or free-skin graft Some quite useless palates from the functional point of view when they are treated by this method combined with a Wardill pharyngoplasty will give a most excellent speech result but only in exceptional cases is this operation indicated (Fig 854)

This radical operation has now been appreciated in so many clinics that it deserves more attention Note that it gives no added disturbance of the maxillary growth and that speech results with obturator in place are uniformly of the best type. The defects are all centred in the need for an obturator with its weight on the teeth its maintenance and above all with fear the patient carries of being found with the plate out

All these defects are well and truly cured with a tube-pedicle insert

FRACTURES OF THE FACE

Principles of treatment.—These are the same as those that are well established or practised in other regions of the body namely — Replacement into normal position at as early a date as possible and retention of fragments at complete rest in this position. The modifications are due to variations of the local position of each fracture Thus any fracture confined to the mandible when teeth are present on both fragments can be replaced and immobilized by fixing the teeth of the lower jaw in occlusion with those in the upper jaw a task which is naturally allotted to the dental surgeon

Fractures of the mandible.—Peculiar fractures of the mandible that of the condyle for instance are not in the majority of clinics treated by replacement rest for the main fragment being sufficient to restore function When a fracture passes behind the last tooth of the body of the mandible an edentulous posterior fragment tends to receive a marked pull forwards and inwards with rotation because of the action of the pterygoid temporal and masseter muscles This fragment so displaced presents great difficulty and there will be considerable loss of function and appearance if it is not adequately corrected Three operative procedures are recommended

1 **Inter-osseous wiring**—If the case is clean when received an incision may be made close to the angle of the jaw through the platysma and the fracture exposed reduced and wired with number 25 s w g stainless steel wire Two wires are better than one and the lower wire near the border may with advantage be put in in the form of a figure of eight * The anterior and large fragment of the rest of the mandible can be fixed to the skull by mechanical means through the upper teeth e g inter maxillary wiring or cap splint

2. An operation described by **Ivy and Curtis**,† amongst others in which through a small incision a hole is drilled in a posterior edentulous fragment and a stainless steel wire loop passed through this hole the wire is then brought through the wound towards the mastoid. A plaster skull cap carrying an outstanding bar in this region is applied and the wire attached to this post in such a way as to retract the posterior fragment into position The objections to this method are

* Stewart Gordon, R C.A.M C., personal communication, 1942.
† Fractures of the Jaws, Philadelphia, 1938.

that only a one-direction pull can be obtained at any given time and a completely firm headcap is not always achieved. If any infection occurs the method is likely to be abandoned

3 *The Roger Anderson crossed pin method*.—*This* has been applied with great success Two crossed pins are passed into each fragment avoiding any roots of teeth in the anterior portion The fragments are manually replaced into position where they are fixed by a crossed bar between the two sets of pins this manœuvre is made possible by universal joints of the Walker Clouston type.* Further rest can be obtained for the fracture by inter maxillary wiring of the main fragment for a week or more In the most successful cases the reposition is anatomical and perfect and can be retained without any complication for many weeks

Fractures of the upper jaw.—These have been classified by Ivy and Curtis † From an operative point of view they can be divided into those which involve a displacement of the upper teeth and those which do not. Where the upper teeth are displaced the displacement may be upward and/or backward or the whole tooth bearing area may be floating including the palate It can usually be manipulated into good occlusion by the application of dental splints when a sufficiently strong fibrous union eventually maintains accurate reposition When there is serious impaction of the displaced tooth bearing area of the maxilla this should be rigidly disimpacted so that the dental surgeon s appliances can work efficiently If slow traction is likely to produce the desired forward movement of the maxilla, it may be provided by a variety of applied forces described in works on jaw fractures ‡ When the fracture of the upper jaw is confined to or includes the middle third of the face a particular facies called dish face is produced In these cases an operation is essential to disimpact the malar bone and the nasal arch from the posterior part of the maxillæ and ethmoids One of the methods described under fractures of the malar should be employed while the nose should be restored as far as possible by complete disimpaction with Walsham s forceps and Ash s nasal septum forceps and the arch be manipulated into normal position.

Fractures of the malar.—Signs and symptoms of this fracture are —

1 Alteration in contour immediate swelling followed by flattening

2 Anæsthesia over the distribution of the infra-orbital nerve.

3 Unilateral epistaxis from hæmorrhage into the antrum.

4 Trismus combined with a deviation of the mandible to the opposite side due to pressure of a displaced malar zygomatic fracture on the tip of the coronoid and temporal muscle

* M. A Rushton and F A Walker Mandibular Fractures treated by Pin Fixation, *Amer Journ. Orthop. & Oral Surgery* 1942, xxviii, 307

† Fractures of the Jaws, Philadelphia, 1938

‡ Fry Shepherd, McLeod and Parfitt, The Dental Treatment of Maxillo-Facial Fractures, Oxford, 1942.

5 Diplopia due to displacement downward of the orbital plane The globe of the eye may be displaced downward and backward (enophthalmos) or there may be proptosis due to the encroachment of the malar element into the orbital cavity

Its replacement may be undertaken by one of the three following methods —

(*a*) **The temporal route** —An inch long incision exposes the temporal fascia clothing the temporal muscle If a lever of the Bristow elevator type is passed down this fascial plane towards the mouth it can be hitched behind and below the tuberosity of the displaced malar and by different leverages achieve disimpaction and replacement No retention is required and the results are most satisfactory This method is applicable mostly to the simpler type of depressed fracture without comminution

(*b*) **The antral route.**—Direct replacement after disimpaction can be readily performed and the floor of the orbit and malar position maintained by direct packing (gauze and Whitehead s varnish) The surgeon may have to wire the frontal process of the malar to the frontal bone and the broken halves of the orbital plate There is a small percentage of late and mild post-operative antral infection

(*c*) **Skeletal traction.**—This may be applied to the malar by driving two crossed pins into it or threading a loop of wire through it and attaching these to a skull cap or bar fitted with a universal joint Old depressed fractures not easily disimpacted are best treated by camouflage operations. The malar prominence can be restored by inserting bone chips or by a block from the ilium A small flat plate slipped along the floor of the orbit will raise the eye level much improve the diplopia and cure the enophthalmos An outstanding case of diplopia of 2½ years history was completely cured by this method.

COSMETIC REDUCTION OPERATIONS

Speaking generally it is easier to reduce than to add and when indicated reduction operations are usually satisfactory to the patient Under this heading are included the reduction of the nasal bridge in humped nose of various deformities of the tip of the nose of excess skin of the face and neck such as wrinkles and double chin of hypertrophied mammæ and of excessive deposits of superficial fat and skin on the abdomen

The nose.—Reduction of the bridge is carried out through bilateral intra vestibular incisions which are continued forward to the tip and then backward into the membranous portion of the septum By this fan shaped incision the bony and cartilaginous framework of the nose is easily exposed on its superficial aspect without in any way incising the external skin. The bony hump can be sawn and chiselled and the cartilage cut with a knife in such a way as to reduce the bridge and shorten the length of the nose from above downwards

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In addition through this same incision any excess or undue prominence of the alar cartilages can be removed Care must be taken to leave a sufficient rim of alar cartilage to preserve the alar margin otherwise an unpleasing effect is likely due to inward collapse of the nostrils In reducing the lining and cartilaginous framework care must be taken to excise a strip parallel with the septum or any excess of the upper lateral cartilages (the triangular expansion of the septum) Otherwise an unpleasant broad effect is left just above the tip The

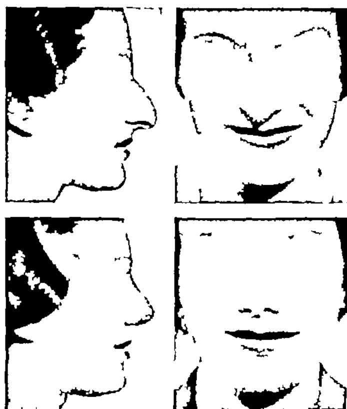


Fig 855.—Overgrowth of bony cartilaginous framework of nose. Reduction and shortening through intranasal incisions.

exact reduction of the alar cartilages must vary with the individual case When a nose has been thus reduced the base of the nose is frequently too broad for its new height in these cases osteotomy with infracture of the frontal processes of the maxillæ is indicated Filing is of more doubtful value Also when a very large and long nose has been shortened and reduced the alæ will be found too big for the new position of the tip and will spread laterally Such a spread can most satisfactorily be dealt with by a wedge excision of the base of the alæ keeping the scar on the cheek nose junction line. On re-suture of the membranous part of the septum the position of the tip can to a certain extent be controlled by the manner in which the catgut

stitches are inserted thus if a tip-tilted effect is required the columella is sutured far forward on the septum and if the tip is to be placed backwards the reverse tactics are applied (Fig 855)

The instruments required for these intranasal manipulations are nasal speculum retractors fine hooks dissecting scissors Howarth s elevator nasal saw and chisels

Nasal reduction is also required in the well known condition of rhinophyma or sebaceous adenomatous hypertrophy Three methods are available (*a*) simple shaving with a razor until a normal contour is obtained leaving epithelialization to take place from tiny islands of skin (*b*) replacement of the whole skin of the nose by flap or skin graft and (*c*) dissection of the adenoma from between raised flaps of skin and underlying cartilage. Each of these methods has given satisfactory results the choice being decided by the individual case

Excess skin of the face and neck. **Eyelids.**—Folds and bags are not only unsightly but those on the upper lid frequently weigh heavily upon the levator muscle often causing the patient to complain of a sensation of weight and fatigue and even chronic headache The folds are picked up with forceps and the amount to be removed by scissors then judged The subcuticular suture used to draw the edges of the gap together is planned to lie in the upper lid in the natural fold above the tarsal plate and in the lower as near the lid edge as is practicable. At the outer canthus in the lower lid it is usually necessary to curve the incision slightly downward as well as outward beyond the canthus for a short distance Great care must be taken in the elderly when the muscles are atonic to avoid producing an ectropion of the lower lid

Forehead furrows and lines in the face are removed by excision of wedges of skin in the pre-auricular and temporal regions and those below the chin by a similar removal in the post-auricular mastoid hair line These two incisions are in some cases made to meet round the lobule of the ear As much undermining of the skin of the face and neck is carried out as is required to obliterate the unsightly lines without producing a mask like appearance of the whole face or undue obliquity of the eyes In certain cases it will be necessary to undermine the skin of the face as far as the malar region where the attachment is occasionally firm In general where a permanent effect is required more extensive undermining is indicated It is not surprising therefore that hæmatoma formation is one of the chief bugbears in this cosmetic procedure and must be dealt with promptly Excessive fat beneath the chin should be removed through the same type of bilateral post auricular incisions so that the scars are subsequently invisible If this cannot be done fat in this area should in my opinion be left alone Horizontal incisions beneath the chin are not satisfactory in that the scars however good they may be are usually noticeable while a vertical scar tends to end in a disastrous cheloid

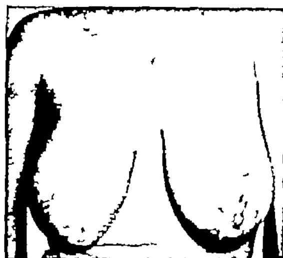
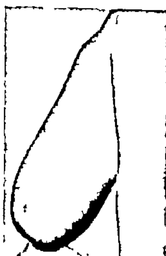
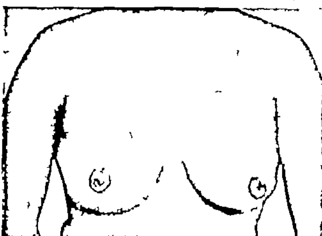
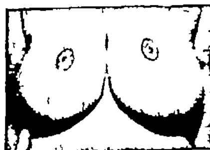





Fig 856A.—Bilateral virginal hypertrophy of the breasts (above) and after operation (below)

First Stage



Second Stage

Fig 856B.—Bilateral virginal hypertrophy of breasts reduction in two stages.

Reduction of the breasts.—Virginal hypertrophy of the breasts is considerably more common than is recognized In a few the condition is attended by no physical or psychic complaint but in the majority there is very considerable embarrassment from the weight and prominence of the mammæ The pull on the chest wall bows the head down and the mammary bulk interferes with the free movements which many women wish to use in sport. On the psychic side the distress is very often marked and the patient contrives many methods of hiding the breasts and many tricks to prevent their size being discovered. Owing to the fact that the medical profession as well as the laity do not realize that reduction can be satisfactorily carried out without unsexing the patient as in the wholly objectionable operation of complete bilateral amputation the condition is often borne without hope of improvement.

Two operations are recommended in both of which the nipple is preserved and re-implanted at a higher level in order not only to maintain certain of its functions but to make the result of æsthetic value. A large quantity of breast tissue fat and skin is removed. The removal of the breast tissue is made justifiable by the fact that the gland is abnormal and that mammary feeding is carried out only with difficulty even if the patient is not operated upon Up to 4 to 15 lb weight has been removed from two breasts Self-explanatory diagrams and photographs of the two operations recommended are given in Figs 856 and 857 When it is specially desired that the incision be kept from extending outwards towards the axilla and where a conical type breast is aimed at a wedge of skin and breast tissue removed from beneath the nipple in its new position will be found satisfactory Its disadvantage lies in the vertical scar which runs down from the nipple over the surface of the breast this scar is found in practice to be a very excellent one if due precaution is taken to relieve it from tension by deep catgut sutures There is a temptation to pull the skin-edges tightly together underneath the breast to get a good shape but the modelling of the breast tissue depends on the fixation by catgut sutures of the mammary tissue itself and the suture of the new mamma to the pectoral fascia. The skin can then be excised in the form of a wedge below the nipple to give a smooth covering without tension and to form a mild support In separating the skin from the breast tissue proper the practice of dry-swab dissection has everything in its favour It reduces the bleeding to a minimum and eliminates a great deal of the shock that might occur in such an extensive operation

The operation has been greatly simplified by the introduction of the method of free grafting the nipples It is very suitable in cases where no lactation is envisaged and in the gross examples of hypertrophy

The abdomen.—Removal of large quantities of skin and fat from the abdominal wall may be done satisfactorily by either a transverse

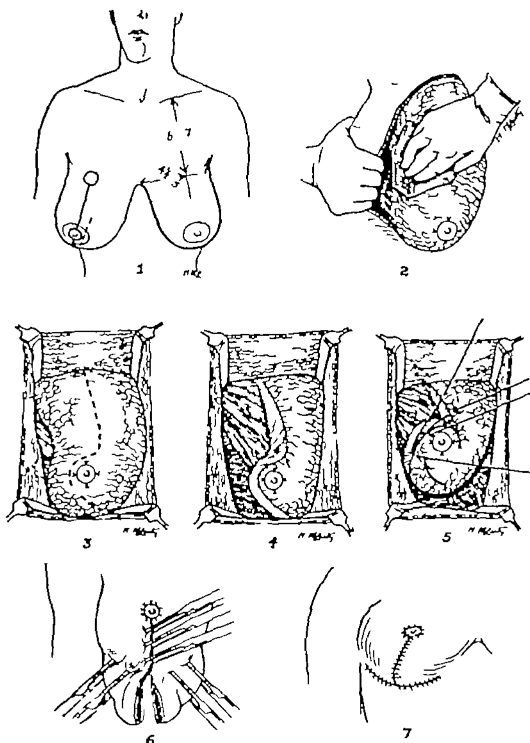


Fig 857 —Operation for reduction of the breasts.

1 Mammary hypertrophy Normal measurements for first incisions.
Sharp dissection of breast tissue from skin and muscles, preserving the inner blood supply
3. Incision to remove outer half of breast delineated.
4. Inner half of breast tissue with nipple preserved on internal mammary vessels.
5. Rotation upwards and outwards to form circular breast. Catgut stitches.
6. Nipple sutured. Excess of skin picked up with Allis forceps.
7 Skin suture

vertical or combined transverse-vertical incision A vertical ellipse including the umbilicus has the advantage of reducing the size of the hips

CHRONIC RADIO-DERMATITIS AND RADIO-NECROSIS

The widespread use of radium and X rays as therapeutic agents and their well recognized potency for evil as well as for good has not unnaturally resulted in a considerable number of cases of chronic dermatitis While many of the milder degrees of burn heal at least for a time under medical treatment chronic ulcerative radio-dermatitis once established admits of one form of treatment only Complete excision is followed by rapid relief of symptoms and freedom from risk of carcinomatous change Cure however cannot be considered as satisfactorily attained if no attempt is made to avoid the secondary contraction which follows healing by granulation Thus the problem of the immediate replacement of the excised tissue with healthy skin brings the condition within the purview of the plastic surgeon.

These patients fall naturally into three groups —

(*a*) Patients who have received a single dose of X rays or radium for diagnosis or treatment

(*b*) Patients who have undergone treatment for a chronic condition and who received small but oft repeated doses for a long period often resulting in ulceration.

(*c*) Professional X ray workers suffering from burns of the hands and face.

In the acute stages the lesion consists of a central slough where the more intense rays have produced massive cell death surrounded by an extensive zone of inflamed skin in which the less powerful rays have produced profound circulatory and functional changes without actually killing the cells *en masse* During this period the inflammatory reaction is so widespread that no line of demarcation between healthy and devitalized tissues can be defined For this reason too early excision and grafting is hazardous and may give poor results The more commonly encountered chronic form of the disease either follows acute necrosis or is chronic from the outset In the latter type of burn the sequence of events is distinguished by an insidious change in the character and functions of the skin and by an equally slow depression of its vitality culminating in intractable ulceration

From a surgical point of view the distinguishing feature of chronic radio-dermatitis is that the whole area can be dissected up from the subjacent tissues with ease there being a well marked cleavage plane between normal and devitalized structures Beneath the ulcer it may be necessary to resect fasciæ tendons muscles or bone in order to reach healthy tissue These are frequently found normal in form but converted into a tough white immobile mass of fibrous tissue The full effect of excessive radiation may not become apparent at once and a

latent period of months or years may intervene between the last dose of X rays and the final breakdown of the tissues Pathologically it is then identical with the chronic stages of radio-necrosis

The indications for operation are —

1 *Pain itching ulceration and discharge*—As a rule with frank ulceration the patient complains of exquisite pain constant day and night and producing a condition of mind and body miserable in the extreme. In the telangiectatic and rind like areas an intolerable itching may drive the patient to despair The relief of pain and irritation and the mental improvement which usually follow immediately when the area is excised are most striking

2. *Deformity from contraction*—As a rule this is much less marked than with burns by fire or scalds owing to the complete absence of cheloid and the smaller amount of fibrous tissue formed It is most frequently met with in patients who have undergone extensive treatment for diseases such as lupus which by themselves produce contraction. It is rather a feature of the condition treated than of the treatment. In the neck a certain amount of retraction of the chin and eversion of the lower lip may take place Contraction deformities also occur in the neighbourhood of the eyes and nose

3 *Cosmetic appearance.*—The unpleasant and disfiguring appearance of the skin especially on exposed parts in the milder degrees of burn unaccompanied by ulceration can frequently be greatly improved by grafting

4 *Epitheliomatous change*—Cancer supervenes so often upon long standing ulcerative radio-dermatitis especially after repeated doses such as occur on the hands of X ray workers that the possibility of its presence can never be excluded by superficial inspection. Microscopical examination of the excised area should therefore never be omitted.

Treatment.—Although this falls naturally into the two stages of (*a*) excision and (*b*) repair it is important to emphasize the point that in the vast majority of cases both stages are carried out at one operation Only in an acute or badly infected ulcer or in one where a healthy base is not obtained after primary excision is it advisable to divide the operation into two stages and to allow the base to granulate before grafting In such instances the diathermy knife is much favoured as an instrument for excision

Excision is usually simple and should extend into healthy skin on all sides A guide to the depth of excision is furnished by traction on the rind like superficial tissues thereby establishing a cleavage-plane which is easily followed. Where the ulcer involves deeper structures such as muscle or bone these should be freely excised and any sequestra removed. An attempt is thus made to reach healthy tissue in all directions but it is sometimes wise to leave deep scar in important organs and trust to the good effect of a healthy skin flap It is rarely

difficult to decide the limits of excision but where epitheliomatous change is suspected the operation should be performed by the diathermy knife and microscopical examination of the edges and base of the excised area carried out In these cases every effort must be directed to thorough removal of all the diseased tissues without thought to the problem of subsequent repair The use of the diathermy knife does not prohibit the immediate application of grafts In our experience a satisfactory take has always resulted

The method of repair depends on the quantity of tissue lost the age and sex of the patient the position of the burn the cosmetic result desired and the mechanical problem of transplanting the graft to its new position. Three methods are available —

(a) Thick split skin grafts
(b) Full thickness dissected grafts
(c) Direct flaps and tubed pedicles

(a) **Thick split skin grafts.**—These applied on a Stent pressure-mould of the defect have a wide field of use and the method is the simplest and most certain available for covering a raw area. Although the immediate result is sometimes disappointing in that the graft may be wrinkled hard and depressed it later becomes soft smooth and filled out and the result compares very favourably with those of other methods Thick split-skin grafts are used as a routine on the hands and fingers of X ray workers on the scalp and back where large areas must be covered and on the eyelids for the relief of cicatricial ectropion. On the front of the neck the method is advisable where a quick result rather than cosmetic excellence is aimed at. It is not so applicable where a thick covering is desirable for weight bearing or where pressure is to be exerted on the surface of the graft. (Fig 858)

(b) **Full-thickness dissected grafts.**—These are not quite so reliable as thick split-skin grafts but undoubtedly give good results when the take is 100 per cent

(c) **Pedicle flaps.**—These may be of the sliding rotation transposed or tubed pedicle variety according to the difficulties to be overcome and the cosmetic result desirable They are particularly applicable where appearance is important where much tissue has been lost and where a mobile covering is required for exposed structures Their chief field of usefulness will be found in extensive burns on the cheek neck and limbs and particularly where joints are involved. They are in fact useful in almost any situation except on the hands and fingers On the scalp small areas may frequently be obliterated by rotation flaps of neighbouring healthy scalp with or without thick split skin grafting of any remaining bare area, so arranged that the hair can conveniently conceal the deficiency Thus in both sexes it is advisable to transpose a bare area from an anterior to a more posterior position so that it can be more easily hidden More complete loss of the scalp should be covered by thick split-skin grafts and a toupée should be worn

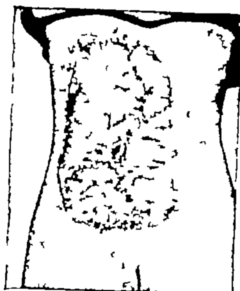



Fig 858A.—Chronic ulcerative radio-necrosis repair by thick split-skin grafts.




Fig 858B.—Ulcerative radio-necrosis of the neck following treatment for tuberculous glands of neck. Right, repair by abdominal tubed pedicle flap.

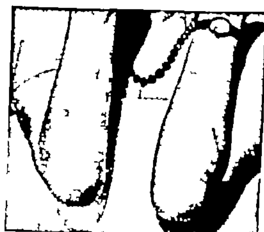


Fig 858C.—Bilateral radio-necrosis of elbow regions treated by excision and direct abdominal flaps.

Facial lesions involve so many problems already discussed that no good purpose would be served by dealing with the matter here. On the neck, according to the age and sex, the thick split skin graft or a pedicle graft is usually employed. In children and in many women the former is satisfactory, while in men a tubed pedicle of the acromio-pectoral variety gives the best results. In women in whom it is desirable to leave the chest unmarked and where time is not a great object a flap raised from the abdomen transferred to the wrist and finally applied to the neck will solve the difficulty (Fig 818 p 1964.) On the abdomen and buttocks sufficient tissue is usually available in the neighbourhood to make sliding or rotation flaps and, provided all tension is avoided, these unite by first intention. The same may be said of small areas on the back but as a rule these are best treated by thick split-skin grafts.

In the axillæ of women anterior and posterior sliding flaps partly fashioned from any excessive skin covering the breasts will give a good cosmetic result, although thick split-skin grafts applied on Stent moulds are also useful. Around the elbow joint and on the forearm flaps may be raised from the side of the chest or abdomen and fitted to the defect according to the technique described later. On the hands and fingers, a particularly common site for burns, thick split-skin-grafting after careful excision is by far the most satisfactory method, because of their thick unwieldy nature full thickness flaps should rarely be employed. Particular attention should be paid to the webs of the fingers, if these are involved, in order to prevent any subsequent limitation of movement. Thick split-skin grafts or direct transposed flaps from the opposite limb are to be preferred for the lower limbs. The latter are almost essential in the region of the ankle-joint where pressure, movement and weight bearing are important.

Results.—It has been already noted that radio-dermatitis and necrosis are cured as soon as excision is completed. The relief of the pain is usually immediate and permanent, even though nothing further is done and the area is left to granulate. The surgical result of healing by granulation is however usually deplorable owing to the contraction deformities which are certain to follow. Success depends entirely on the technical excellence of the plastic treatment.

In general it might be said that the results are most favourable with thick split skin grafts and flaps, and that a successful repair in this type of burn may be more confidently predicted than after burns by fire.*

* Gillies and McIndoe "Plastic Surgery in Chronic Radio-dermatitis and Radio-necrosis," *Brit. Journ. Radiol.* New Series, Mar 1933 No 63 vi, 132.

CHAPTER XXXVI

OPERATIONS ON THE NECK

By the late W E TANNER

Proofs revised by A. J Gardham

SURGICAL ANATOMY

The cervical lymph system.—The lymphatic vessels and nodes in the neck are arranged in two main groups (Fig 859) —

1 A **horizontal system** at the junction of the head and neck which drains into two vertical systems of deep cervical nodes lying on the course of the internal jugular veins The horizontal chain contains the following groups —

i The *submental or suprahyoid nodes* lie superficial to the mylo-hyoid muscles and receive afferent lymphatics from the skin of the lower lip and chin from the mucous membrane of the front part of the floor of the mouth and the tip of the tongue Their efferents drain into the anterior nodes in the upper part of the deep cervical chain

ii. The *submaxillary nodes* in the digastric triangle lie superficial to deep to and in the folds of the submaxillary salivary gland. The posterior nodes become continuous with the upper deep cervical nodes and lie in contact with the facial artery and anterior division of the temporo-maxillary vein Their afferent lymphatics drain the front part of the face the inner side of the orbit the mucous membrane of the mouth the teeth and gums and the anterior part of the tongue. Their efferents pass into the anterior nodes of the upper deep cervical chain

iii The *parotid or pre-auricular nodes* lie on the surface of and immediately beneath the parotid fascia, and embedded in the folds of the parotid salivary gland. The lowest members of this group are in contact with the temporo-maxillary vein and the commencement of the external jugular vein the external carotid artery lies more deeply Their afferents drain the external and middle ear the anterior part of the scalp the temporal region and eyelids.

iv The *mastoid or postauricular nodes* lie on the mastoid process behind the ear

v The *occipital nodes* lie on the upper part of the complexus muscle

vi. The *superficial cervical nodes* lie along the upper part of the external jugular vein between the sternomastoid and trapezius muscles. These three groups of nodes receive afferent lymphatics from the posterior part of the scalp the external ear and skin of the neck. Their efferents pass to the deep cervical nodes. The superficial cervical nodes are often enlarged by a retrograde infection spreading backwards from the tonsillar lymphatic nodes.

2 The **vertical systems** of deep cervical nodes lying along the course of the internal jugular veins receive afferent lymphatics from the

tonsils nasopharynx pharynx larynx œsophagus and trachea the efferents from the horizontal chain of nodes and lymphatic vessels which pass directly to them from areas also drained by the horizontal nodes. Anatomically the deep cervical system consists of two chains one *antero-external* and the other *postero-external* to the internal jugular vein These two chains are subdivided into four groups by the anterior belly of the omo-hyoid muscle. This subdivision is convenient on

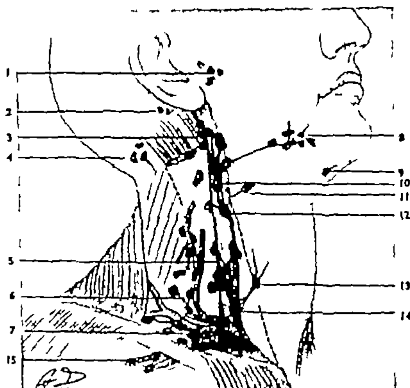


Fig 859 —Horizontal and vertical systems of cervical lymphatic nodes. The part of the sternomastoid muscle reflected downwards is shown in outline

1 Parotid or pre-auricular nodes; 2, mastoid or postauricular nodes; 3, postero-superior nodes of vertical chain, 4, occipital nodes; 5 13, 14, antero-inferior nodes of vertical chain; 6, 7 postero-external nodes of vertical chain 8, submaxillary nodes, 9, submental or suprahyoid nodes; 10, 11 12, antero-superior nodes of vertical chain 15 infraclavicular nodes.

clinical and pathological grounds because each of the four groups receives afferents from certain parts of the periphery but as each group is joined by intervening lymphatics the primary focus of disease is eventually masked by infection spreading from one group to the others

The two upper groups lie above the anterior belly of the omo-hyoid the *antero-superior* lying in front of and external to the internal jugular vein the *postero-superior* lying behind the internal jugular vein

The two lower groups lie below the anterior belly of the omo-hyoid muscle surrounding the terminal parts of the internal jugular external jugular subclavian transversalis colli and suprascapular veins and becoming continuous with the axillary and mediastinal lymphatic

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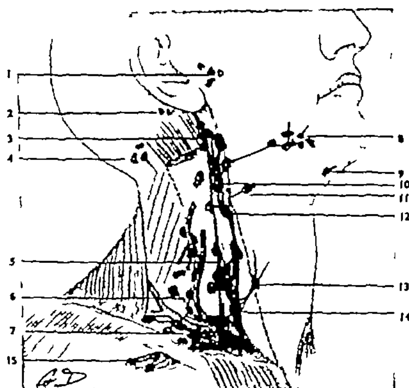


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nodes The *antero-inferior* are continuous with the antero-superior chain and lie on the internal jugular and the termination of the subclavian veins The *postero-inferior* are continuous with the postero-superior chain and lie behind the internal jugular vein on the brachial plexus in intimate relation with the transversalis colli supra scapular, and external jugular veins and the outer part of the subclavian vein

i. The ANTERO-SUPERIOR chain receives afferents from the submental submaxillary and parotid lymph nodes and also vessels which pass to them directly from the buccal cavity the tongue palate jaws and teeth the tonsils the oro- and naso-pharynx. This group is the one most commonly first affected by the direct spread of tuberculosis along the lymphatics from the mucous surface of the naso-pharynx.

The *tonsillar* lymph node lies on the common facial vein at its junction with the internal jugular and receives lymphatics direct from the tonsil. When enlarged this node is felt just below and behind the angle of the jaw under the anterior border of the sternomastoid.

The *principal lymph node of the tongue* lies on the internal jugular vein opposite the bifurcation of the common carotid artery The transmitted pulsation of the vessel can be seen and felt over the node when it is enlarged. A swelling projecting from under the anterior border of the upper part of the sternomastoid muscle is a further indication that the antero-superior group is enlarged. The mass may be adherent to the superficial layer of the deep cervical fascia. The deeper nodes may be adherent to the common facial and internal jugular veins

ii. The POSTERO-SUPERIOR chain lies under the posterior part of the sternomastoid muscle behind the internal jugular vein These nodes receive afferents from the retropharyngeal parotid posterior auricular occipital and superficial cervical lymph nodes and also from vessels which pass directly to them from the mucous membrane of the naso-pharynx the pharyngeal tonsil Eustachian tube middle ear and nasal fossæ. Lymphatics from the *pharyngeal tonsil* pass directly to a group of nodes lying deep to the sternomastoid just below the tip of the mastoid process on the rectus capitis lateralis muscle. The spinal accessory lies in intimate relation with these nodes just after it has crossed superficial or deep to the internal jugular vein

When enlarged the postero-superior group projects from under the sternomastoid into the posterior triangle and is traversed by the spinal accessory nerve and branches of the cervical plexus of nerves

iii. The ANTERO-INFERIOR chain lies on the outer side of the internal jugular vein on the scalenus anticus muscle in intimate relation with the phrenic nerve and the thoracic or right lymphatic duct. These nodes receive afferents from the antero-superior group of nodes and vessels which pass directly to them from the larynx trachea œsophagus and thyroid. Their efferents communicate with the superior mediastinal nodes

Tuberculous disease commonly spreads to these nodes from the upper cervical groups but they become enlarged before the upper nodes when the disease is secondary to mediastinal or mesenteric infection

iv The POSTERO-INFERIOR chain lies behind the internal jugular vein on the levator anguli scapulæ scalenus medius and upper part of the serratus magnus muscles in intimate relation with the lower branches of the cervical plexus and the brachial plexus Afferent vessels pass to this group from the postero-superior chain and from the axillary nodes Their efferents communicate with the inferior group of cervical nodes and the mediastinal nodes

The **retropharyngeal nodes** lie behind the upper part of the pharynx in front of the prevertebral fascia and rectus capitis anticus major muscles They receive afferents from the nasal fossæ naso-pharynx and Eustachian tubes their efferents pass to the upper deep cervical nodes When suppurating they form a swelling on either side of the middle line as seen from the mouth the postpharyngeal abscess resulting from caries of the cervical spine is usually median in position and behind the prevertebral fascia. In either case an abscess may be of such a size that it extends into the neck and presents at the posterior border of the upper part of the sterno-mastoid.

The **suprasternal nodes** lie in the space of Burns just above the manubrium sterni The term Virchow s node is sometimes applied to lymph glands of the inferior cervical group on the left side when infiltrated by carcinoma secondary to a primary growth in the abdomen They lie in proximity to the junction of the internal jugular vein with the subclavian and may be felt just behind the lowest part of the sternomastoid muscle

The lymphatics of the head, face and neck.—The scalp—The lymphatic vessels from the frontal region end in the *parotid* nodes from the temporo-parietal region in the *parotid and posterior auricular* nodes from the occipital region in the *occipital superficial cervical and deep cervical* nodes

The ear and external auditory meatus.—Vessels from the outer surface of the ear and anterior wall of the external auditory meatus pass to the *parotid* nodes from the margin and upper part of the inner surface of the pinna, the inner surface and posterior wall of the meatus to the *posterior auricular and upper deep cervical* nodes from the floor of the meatus and lobule of the pinna to the *superficial cervical and upper deep cervical* nodes

The face.—The lymphatics from the eyelids and conjunctivæ end in the *parotid* and *submaxillary* nodes from the posterior part of the cheek in the *parotid* nodes from the anterior part of the cheek the side of the nose the upper lip and the lateral third of the lower lip in the *submaxillary* nodes

Vessels from the temporal and zygomatic fossæ pass to the *internal maxillary* and *upper deep cervical* nodes the deeper vessels of the cheek

suitable diet has made such methods more often curative than merely palliative (*See* Vol I p 26)

It is interesting to note as showing the influence of climatic and industrial conditions on the course of the disease that surgeons in the north of England and Scotland favour early operative treatment while in the south of England the tendency is towards conservative methods

The more satisfactory plan is to combine both confining oneself to conservative measures in the early stages when resolution is possible and resorting to surgical procedures when the disease is progressive and likely to end in caseation or suppuration and to extend beyond the glands Both schools are agreed that diseased foci of infection in the throat and mouth—septic tonsils adenoids and decayed teeth—should be eliminated at the outset of treatment.

In some cases although there may be no physical signs of tuber culosis elsewhere the type of patient the signs of intoxication and the condition of the nodes indicate that the natural course of the disease will end in caseation sinus-formation secondary septic infection and tuberculosis of the skin Here early removal is indicated

On the other hand there are cases in which there is every reason to suspect that the disease has spread beyond the limits of the neck although the nodes are hard elastic and discrete Here conservative methods should be the primary choice

In some cases early removal should be undertaken because even now tuberculous disease of the neck with suppuration and sinus-formation is frequently seen in spite of efficient conservative treatment

More commonly suppuration and sinus formation occur where there has been inefficient conservative treatment or no treatment at all

Excluding the rarer conditions seen most commonly in adults in which the enlarged cervical nodes have become infected secondarily to disease in the mesentery or mediastinum tuberculous cervical adenitis is in many instances at first a local lesion which can be completely eradicated by excision

Economic considerations have an important bearing on the choice of the method of treatment.

Selection of the appropriate treatment in individual cases.—In coming to a decision on this question every aspect of the case must be weighed up carefully viz. (1) the localization of the disease (the nodes should always be examined with the patient lying down to relax the neck muscles) (2) the patient s general condition as regards tuberculosis and other diseases (3) the influence of the local on the general condition and vice versa (4) the patient s economic status home surroundings family history and responsibilities (5) the probable effect of excision on the general condition The prognosis should be guarded and the patient or those responsible made to realize that if an operation is carried out it is only one step in treatment general measures and observation for some years being also essential.

The time taken by conservative treatment is an important consideration to those who cannot afford to suspend their activities at school or daily employment for several months or possibly for years. Even those to whom time and money are unimportant may be ill advised to give up their pursuits for years when early operation offers them the better prospect of cure Conservative treatment cannot be relied upon in all cases to clear up the local condition before the disease spreads to other parts of the body and seriously prejudices the general health.

In the course of the so-called natural process of cure caseation suppuration infection of the skin sinus-formation and secondary pyogenic infection are quite common. Further the nodes may become enlarged again from lighting up of the old disease or from a fresh infection

It is clear therefore that a dissection of the infected nodes should be done when eradication of septic foci in the throat or mouth and careful general treatment do not cause a diminution in their size in a few months when the disease shows a tendency to spread and particularly before caseation extends outside the capsule of the nodes or suppuration takes place To take some specific examples

1 *The nodes though enlarged are hard discrete and freely movable* — Palliative treatment will in the majority of cases lead to a rapid diminution in the size of the nodes and the general health will improve. In others the nodes will remain enlarged with no sign of matting or caseation In the minority the nodes will enlarge and become confluent in these cases the nodes should be excised before caseation takes place When there are profound anæmia enlargement of the glands in the groin and axilla, a rise of temperature and enlargement of the spleen the diagnosis of Hodgkin s disease must be excluded.

2. *An elastic fixed ill-defined mass of nodes beneath the sternomastoid and deep fascia with induration of the tissues around the nodes the skin over the nodes hyperæmic but freely movable on the deep fascia the hyperæmia due to a subacute non suppurative periadenitis* —Operation is definitely contra indicated in such cases as these. Conservative measures will lead to a resolution of the periadenitis and in the majority of cases the enlargement will subside. Such a periadenitis seems to hasten the natural processes of cure. A similar condition is often seen during treatment by X rays or by heliotherapy

3 *A mass of softening nodes attached to the superficial layer of the deep cervical fascia with infiltration of the skin imminent* —The nodes should be excised beginning the dissection where they are not attached to the superficial layer of the deep fascia.

4. *A chronic abscess not involving the skin and obviously fluctuating* —This is a condition frequently found when the source of infection is tonsillar The contents of the abscess may be quite fluid Repeated aseptic aspiration will cure the majority of such cases even when ideal hygienic surroundings are not available

5 *A fixed mass of nodes under the deep fascia with a subcutaneous*

abscess —The abscess is opened the hole in the deep fascia found and the caseous node just beneath it curetted The skin is sutured If the glands do not resolve without signs of further caseation they should be removed

6 *A fixed mass of nodes involving the skin or possibly a sinus* —The nodes should be removed through an incision avoiding the diseased skin the sinus is excised separately These cases frequently do badly under conservative treatment The nodes continue to enlarge and break down or the disease spreads widely in the skin as a tuberculous lymphangitis

7 *A mass of nodes infiltrating the upper part of the sternomastoid muscle* —The mass should be excised together with the affected part of the muscle.

8 *A mass of nodes in the lower part of the neck fixed to the clavicle infiltrating surrounding tissues the skin red or blue and œdematous* — This is commonly senile tuberculosis secondary to mediastinal tuberculosis Generally only palliative measures are indicated.

9 *Recurrence after palliative treatment* —Septic foci in the throat or mouth should be removed before excision of the nodes If the tonsils are very septic removal particularly by enucleation may set up acute inflammation in nodes which are already softening This danger can now be minimized by covering the operation of tonsillectomy by penicillin Alternatively the usual order of procedure may be reversed the nodes are excised first and the tonsils removed at a second operation when the wound in the neck is soundly healed It is not advisable to deal with the tonsils at the time the nodes are excised because of the danger of suppuration and of soiling the neck wound The additional loss of blood may also be a matter of great importance There is also the risk of aspiration of blood at the end of a long operation when the patient may remain under the influence of the anæsthetic for a long time.

Excision of the glands is usually contra indicated when there is evidence of advanced disease in other parts of the body or when signs of general intoxication and fever indicate active general disease The local trauma of operation may set up an acute toxæmia or generalized tuberculosis.

P.A.S and I N H —Various anti tuberculous drugs have been quite recently discovered and they are sometimes of value in the treatment of tuberculous glands Their use as a means of treatment or to supplement other forms of treatment should be considered in the following circumstances —

1 *The acute invasive stage* in which one or more groups of glands enlarge rapidly and show evidence of peri-adenitis In such cases anti tuberculous drugs rarely produce complete resolution but they reduce the size of the glands and the extent of the peri adenitis and so make operation more easy and less dangerous In such cases a six-weeks course of streptomycin with the addition of either P.A S or

Isonicotinic Hydrazide should be given and operation undertaken when it appears that the glands have ceased to diminish in size but are still large enough to make it seem probable that caseation has occurred.

2. *In cases in which quiescent glands show signs of activity* during pregnancy or as a result of illness diminishing the general resistance In these cases a full course of streptomycin and either I N H or P.A.S should be given and repeated after an interval if necessary

3 *When it is proposed to undertake operation for glands which have infected the skin* or have given rise to a large extra-glandular abscess. In such cases operation is best undertaken when the patient is in the middle of a full course of treatment by anti tuberculous drugs.

4. *In cases of extensive glandular disease with sinuses and skin infection* there is no good evidence that anti tuberculous drugs influence the course of the disease but they are used by some surgeons more often in America than in this country

Local injections of P.A S (20 per cent.) or streptomycin (up to 250 000 units in aqueous solution) have been used in the treatment of sinuses and to sterilize an abscess cavity which has been aspirated. It is doubtful whether local instillations of this type have any real value.

Sources and paths of infection.—In the majority of cases of septic infection of the cervical nodes the organisms reach the nodes directly along the lymphatics from infected cutaneous or mucous surfaces. In tuberculous infection there is often proof that the bacilli reach the nodes directly along the lymphatics from infected mucous surfaces such as the faucial and pharyngeal tonsils Enlarged nodes underneath the upper third of the sternomastoid are associated with diseased *tonsils or adenoids After removal both the nodes and the tonsils* or adenoids may be found to contain tubercle bacilli.

Skin infection can rarely be proved to be the direct cause of tuberculous nodes

In other cases the enlargement of the cervical nodes is secondary to mediastinal and mesenteric infections. There is another possible path of infection which has not hitherto received the attention it deserves the bacilli may reach the nodes by way of the blood-stream

It is clear both on pathological and on clinical grounds that septic and tuberculous infections of the nodes are *intimately related to one* another Septic infection of the nodes favours the growth in them of tubercle bacilli Secondary septic infection of nodes primarily tuberculous may lead to the formation of a localized acute abscess *containing fluid (pus) or may hasten* the spread of the disease beyond the nodes.

The most common primary sources of infection are the naso-pharynx diseased tonsils or adenoids in other cases the teeth, infection of the scalp (pediculi) or of the external and middle ear give rise to enlargement of the nodes which is primarily or potentially tuberculous. The

intimate association of septic and tuberculous infection makes it difficult to decide when the nodes are in a condition of chronic septic inflammation and when they are tuberculous. For practical purposes we may regard all inflamed lymph nodes as tuberculous if they are still enlarged or increasing in size four to eight weeks after all possible foci of septic infection have been removed If syphilis be excluded persistent hyperplasia of the cervical lymphatic nodes is practically always tuberculous persistent enlargement of non tuberculous septic nodes after the primary focus has been removed being so rare as to be negligible Grey Turner has frequently referred to this question His views* are epitomized as follows —

There are two great groups of patients in whom the cervical nodes become tuberculous. In one the infection is local and arises from the tonsils naso-pharynx or more rarely from the teeth and in the other a primary infection of the mesenteric or mediastinal glands is the portal of entry The clinical features of the two groups are as follows

Naso-pharyngeal group —

(1) Begin to give trouble in the early years of life before puberty
(2) Often associated with a throat illness
(3) Tonsils usually enlarged or adenoids present or both.
(4) First noticed in upper part of the neck and after onset general health not much affected
(5) Not usually calcified
(6) No evidence of tuberculosis elsewhere
(7) Prognosis after radical operation uniformly good

Mesenteric or mediastinal group.—

(1) Become active after puberty or later
(2) Not associated with throat illnesses.
(3) Tonsils not usually enlarged adenoids not present
(4) First noticed in the root of the neck. Often associated with enlarged nodes in the axillæ or groins
(5) General health usually poor
(6) Often calcified
(7) Often clinical or X ray evidence of tuberculous nodes in the mediastinum or mesentery
(8) Prognosis always uncertain

In the naso-pharyngeal group any existing source of infection such as diseased tonsils and adenoids must be removed first If after treating the focus the enlargement does not disappear in the course of two to four weeks then the best plan is to carry out a thorough surgical removal and by a carefully planned dissection clear out the highest part of the carotid triangle This may have to be done on both sides.

In the mediastinal or mesenteric group radical removal should never be carried out in the first instance. General hygienic measures are the first essential but surgical intervention may be necessary if the

* *Newcastle Med. Journ.*, July 1931 h, 145, and personal communication to date.

nodes remain persistently tender or break down or if there are repeated attacks of periadenitis or if after the general infection is presumably quiescent a mass of nodes remains as an unsightly annoyance

Removal of Tuberculous Lymph Nodes

The surgeon having decided after carefully weighing the clinical pathological and economic factors of the case that the diseased nodes should be excised the future history, so far as he is concerned will depend on four essentials—(1) a rigid aseptic technique (2) an accurate knowledge of the anatomy of the neck (3) complete removal of all nodes in the region operated on and not merely those which are obviously diseased and (4) efficient after-care.

(1) *Asepsis* —To secure primary union of the wound and minimize auto inoculation the tissues should be treated with the utmost gentleness Grossly-damaged tissues will be more vulnerable to septic organisms gaining access from without and to tubercle bacilli and their toxins which are bound to escape in small numbers from the nodes and divided lymphatics even at a carefully conducted and gentle operation Strong coagulating antiseptics should not be swabbed over the surface of the wound to destroy escaped bacilli they injure the tissues they are designed to protect and increase the local inflammatory reaction

The dissection should be carried out with knife and scissors the temptation to dislodge the nodes with the fingers being studiously resisted. They must be removed *en masse* with the cellular tissue and fat in which they lie The surgeon should be in no hurry and should clear out the whole of an infected group or rather anatomical group with a margin of unaffected nodes Important nerves must not be sacrificed.

(2) *Anatomical knowledge* —This subject has already been considered.

(3) *Complete removal of the diseased nodes* —It must have been the experience of all surgeons at one time or another to have patients on whom they had operated a few months previously returning with a recurrence of enlarged nodes beneath or near the scar Presuming that the primary focus has been removed such recurrence is serious because it shows either that the infection was virulent or that there is a lack of resistance It must be remembered that the extent of disease in the neck bears no direct relation to the degree of general ill health. One small infected node left behind is a focus from which the disease may spread to nodes lower down in the chain or to other parts of the body If operation is undertaken at all it must therefore be with the definite object of removing all the infected nodes.

(4) *After-care* —Although the surgeon may feel that he has removed the focus of disease after extirpating nodes such as the naso-pharyngeal group tuberculous infection is so insidious in its course and protean in its manifestations as to shake confidence in the permanence of any measure designed to eradicate it however sound in conception and complete in execution.

Whenever possible the patient should live in the country or at the seaside under good hygienic conditions for at least six weeks—or longer—after discharge from hospital and on his return to his usual life must continue to observe good hygienic conditions under medical supervision If in four or five years there is no return of symptoms the surgeon may be optimistic and hope that the disease has been eradicated and that the patient is more resistant to fresh infection than before

Preparation of the patient.—Except when an abscess requires early attention operation should not be undertaken until resistance has been raised to the highest possible point by general measures directed to that end Attention having been paid to the throat and teeth the patient should be admitted to hospital at least twenty four hours before the proposed operation to get used to the surroundings and to enable a thorough general examination (particularly of the throat mouth and lungs) If a purge is necessary it should be given on the morning of the day before operation A strong purge given the night before an operation is bad and inconsiderate treatment

Preparation of the area of operation.—The lower part of the scalp behind the ear is dry-shaved and the whole of the neck and lower part of the face on the diseased side is wrapped in an antiseptic compress at least twelve hours before operation In adults the skin is washed with acetone painted with tincture of iodine or 2-per-cent picric acid solution and covered with a dry sterile compress In young children iodine irritates the skin and plain spirit may be used instead.

Half an hour before the operation a child should be given $\frac{1}{250}$ gr and an adult $\frac{1}{100}$ gr of atropine sulphate hypodermically to diminish mucous secretion. If not particularly contra indicated and if the anæsthetist wishes it $\frac{1}{6}$ or $\frac{1}{4}$ gr of morphia may also be given to adults but scopolamine should not be used even in nervous patients on account of its tendency to cause cyanosis and unnecessary hæmorrhage.

The anæsthetic.—These operations do not lend themselves to any form of local anæsthesia Some surgeons favour rectal anæsthesia in order that the anæsthetist may be kept away from the operation area. Any of the accepted methods of general anæsthesia may be employed but marked venous congestion must be prevented as it hampers the operator The risk of sepsis consequent on the close proximity of the anæsthetist to the field of operation is most easily overcome by the use of intratracheal ether or nasal anæsthesia. If these are not available the anæsthetist may wear sterilized rubber gloves or the field may be protected by fixing a semicircular hoop of metal to the operating table or by so placing an anæsthetic cage over the head that it lies at the level of the mouth Sterile towels are arranged over the hoop to shut off the anæsthetist without interfering with his access to the face and upper air passages (Fig 862) One towel hangs vertically from the loop or cage and is fixed with towel

clips to the chin just below the lobule of the ear and to the external occipital protuberance Failing a hoop or cage the surgeon lays the upper half of a sterile towel over the face the anæsthetist then grasps the symphysis of the jaw and the lower part of the towel is thrown over his hand (Fig 868)

Instruments.—In addition to the general set the following are required two pairs of node-holding forceps a pair of Mayo s dissecting

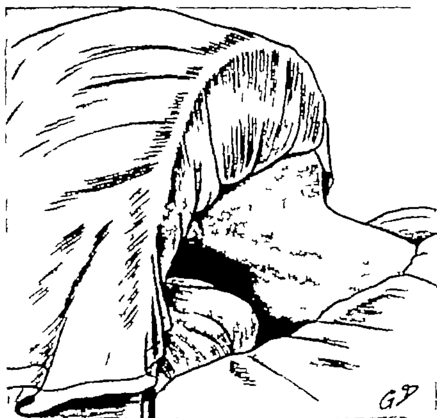


Fig 862.—Arrangement of sterile towels over semicircular hoop of metal, completely to shut off field of operation.

scissors blunt pointed and curved on the flat and at least two dozen pairs of curved artery forceps Kocher s or Sargent s The latter artery forceps are particularly useful to fix the towels to the platysma and subcutaneous tissues when shutting off the skin from the wound because they lie conveniently out of the way with the points concave downwards in the wound

Positions of patient and surgeon.—The patient lies in the dorsal position with a small hard pillow under the neck and the face turned away from the side requiring operation. The arm on the affected side is drawn well down and fixed by the side of the trunk with the hand under the buttock The hair and scalp are enclosed in a rubber cap

and sterile wool is placed under the neck to absorb blood The head is raised from the table and two sterile towels are held under the head and neck the lower one is dropped on the operating table and the upper one is folded round the head and fixed over the forehead The metal hoop is then fixed over the head and sterile towels are arranged to cover everything except the field of operation

The surgeon stands on the side to be operated on with the first assistant on the opposite side a second assistant should stand next to the surgeon at the head of the table

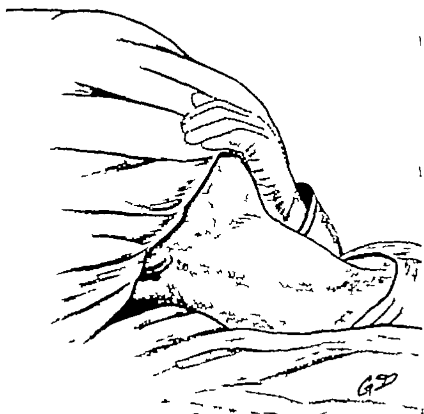


Fig. 863.—Arrangement of sterile towels without metal hoop, completely to shut off field of operation. Anæsthetist's left hand is outlined beneath towel.

The incision.—The position of the incision will vary according to the site and size of the masses but in all cases incision must be free because the disease is always much more extensive than external examination suggests. Further the aim of the operation is to remove all the diseased nodes to prevent unnecessary hæmorrhage by seeing and picking up vessels before dividing them and to dissect important structures from the nodes without injuring the edges of the skin incision or the deeper structures by excessive traction. Hæmostasis and due regard to the anatomy of the parts are impossible through a small incision As a general rule the incisions should follow the principles

laid down by Kocher and lie in or parallel with the normal creases or folds in the neck and correspond to the lines of stress Such scars in course of time become almost invisible and do not stretch. Vertical incisions at right angles to the clavicle should be avoided whenever possible they tend to stretch and in children and in adults with short thick necks they do not give such a good exposure as transverse or oblique incisions. Triradiate incisions meeting at an acute angle do not heal well the points may slough and lead to ugly depressed scars. A few scratch marks should be made with a cutting needle at right angles to the direction of the incision to act as a guide for placing the sutures in order to secure accurate coaptation of the skin independently of the position of the head. By keeping well behind the angle of the jaw and below the body of the hyoid bone the nerve supply to the depressor labii inferioris and risorius is preserved in the upper flap

The various incisions are described when dealing with the removal of glands in the separate regions (*see also* Fig 866)

Block dissection is seldom required for tuberculous disease of the glands of the neck. In the exceptional cases in which it is necessary the triradiate incision (*see* p 2041) used for block dissection of malignant glands is suitable

The naso-pharyngeal and lower nodes of the vertical chain may be removed through a ʃ-shaped incision The horizontal limb commences just below the body of the hyoid bone passes backwards and upwards 1 in behind the angle of the jaw to just below the mastoid process and then curves gently backwards into the vertical limb which runs down the posterior triangle of the neck parallel with and 1 in in front of the anterior border of the trapezius.

Technique.—The superficial fascia and platysma are divided along the whole length of the wound and are dissected up together Hæmorrhage is usually free until the platysma has been divided. The superficial bleeding points are picked up and ligatured with very fine catgut. The skin is then shut off from the depths of the wound with two towels fixed to the subcutaneous tissues (not to the skin) with curved artery forceps and at each end of the wound with a pair of tissue forceps. (Fig 864) The deep fascia is divided with a fresh knife, and flaps of skin superficial and deep fascia, are raised until well beyond the superficial limits of the disease.

Vessels are tied off with catgut during the dissection so that the manipulations are not interfered with by an accumulation of artery forceps. The assistant should have a pair of dissecting forceps in his left hand throughout the operation and with these should swab the wound dry with firm momentary pressure and not by continuously rubbing or lightly wiping its surface The dissection is then carried into the loose connective tissue surrounding the capsule of the nodes commencing at a point where they are not adherent to the deep fascia. In freeing the nodes care must be taken to be in the right layer If

in the right layer the nodes are easily dissected off by snipping the connective tissue round their capsules with Mayo s scissors and then opening the blades of the scissors repeating this manœuvre systematically without removing the scissors from the wound until a definite piece of work has been done Blunt dissection must not be carried out with the handle of the knife or the fingers The nodes must not be forcibly avulsed and freed by cutting blindly in the depths of the wound In this way large veins (which when stretched look like connective tissue) and nerves may be injured and hæmorrhage even from small vessels which have retracted and become buried in the depths of the wound can only be arrested with difficulty and tedious waste of time If the nodes are adherent they must be dissected off with the scissors or a sharp scalpel the cutting edge directed towards them Node-forceps should be dispensed with altogether or at any rate only be used in the later stages of the operation because they are likely to burst the nodes and set free infected material

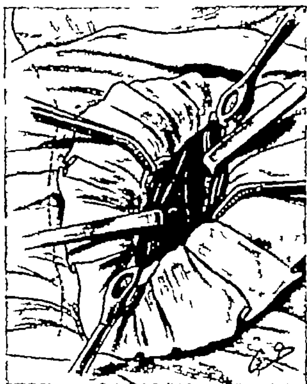


Fig 864.—Method of protecting wound from skin.

Any remaining bleeding vessels are tied with catgut Care should be taken that the wound is quite dry and that there are no large open veins which may bleed as soon as the patient comes round from the anæsthetic It is sometimes recommended that the patient be made to cough or strain just before the wound is closed to show up any unsecured veins a proceeding which may have embarrassing consequences at the time but which prevents the subsequent development of hæmatoma.

In extensive operations where there is much oozing and to prevent the accumulation of lymph which escapes from the divided lymphatics into the dead spaces of the wound a small rubber-glove drain is brought out of the most dependent part of the wound through a separate small incision This drain is usually removed in twenty four or forty-eight hours A stiff rubber tube may cause hæmorrhage by ulcerating into the vessels lying unprotected in the wound

The deep fascia superficial fascia and platysma on each side of the

wound are accurately coapted with a single layer of interrupted catgut sutures arranged so that the corresponding scratches in the skin are in accurate apposition The skin-edges are everted and brought together with Michel s clips or with a subcuticular stitch of silkworm-gut a small piece of this material should be placed under the centre of this stitch to facilitate its removal in two halves The ends may be secured by knotting or by threading a small lead shot on each and compressing them with special forceps

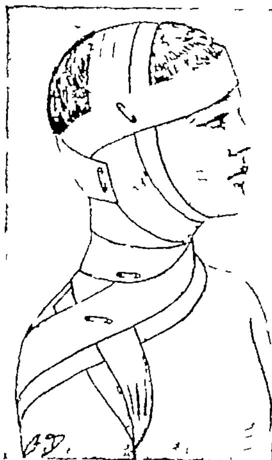


Fig 865.—The bandage.

The dressing —The wound is covered with a copious dressing of dry sterile gauze and plenty of wool pressure being kept on the wound until the dressings are securely bandaged. The wool and bandages are not merely to fix the dressings and prevent access of septic organisms despite movements of the head but are designed to act as a splint to secure proper rest to the injured tissues A simple spiral is not satisfactory the bandage should commence with *spiral turns directed forward* from the side operated on, carried downward as a figure-of eight round the neck and axilla, then brought upwards as a spiral round the neck going over the top of the head in front of and behind the ear followed by a few turns round the forehead. (Fig 865) Pins are fixed where the turns of the bandage cross one another The pressure of the bandage may cause blueness of the face until the patient comes round from the anæsthetic

After-treatment —The patient is put back to bed in the dorsal position with the head turned away from the diseased side and must not be left until quite conscious A tongue forceps and gag should be ready in case of respiratory embarrassment Even in children where a proportionately large area of the body has been exposed there is rarely severe collapse or shock. Rectal saline at 110° F with aspirin or bromide should be given in quantities of one pint at a time during the first thirty-six hours to supply fluid during the period when *swallowing may be painful Intravenous or subcutaneous salines*

should not be given because they increase the exudate from the divided lymphatics in the wound and favour sepsis The unpleasant taste of the anæsthetic is eliminated by giving the patient a small piece of lemon to suck or a little vinegar to sip

The first dressing to remove the tube must be conducted aseptically it is a disadvantage of drainage that the dressing must be disturbed so soon In uncomplicated cases the wound should not be examined before the seventh to the tenth day when the stitches are removed.

Local rest should be maintained for at least a fortnight the patient although sitting up after the first twenty four hours must have the head and neck supported by pillows

Small exudations of lymph in the wound are usually absorbed without drainage but a collection large enough to produce tension on the stitches must be let out with sinus forceps

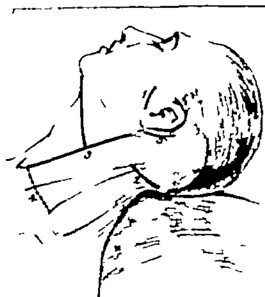


Fig 866 —Incisions for removal of cervical lymph nodes.

1, Parotid or pre-auricular 2, occipital ; 3, submaxillary and anterior deep cervical nodes 4, incision made when necessary to give access to lower nodes of vertical chain 5, posterior auricular or mastoid.

Incisions for removal of the different groups of nodes. *The pre-auricular or parotid nodes* (Fig 866 1)—The superficial nodes may be removed through a transverse incision just in front of the ear although most surgeons now prefer a vertical incision immediately in front of the external auditory meatus The pes anserinus lies beneath the glands in the substance of the parotid and Stenson s duct is on a deeper plane and in front.

The *postauricular nodes* are removed through a transverse or vertical incision just behind the ear (Fig 866 5)

The *occipital nodes* (Fig 866 2) may be removed through an incision running downwards and forwards from the anterior border of the trapezius The great occipital nerve and occipital artery lie deep to the nodes

The *superficial cervical nodes* are removed through a transverse incision over the upper part of the posterior triangle and sternomastoid muscle

The *submental nodes* are removed through an incision just below and parallel with the mandible or through a vertical incision from the symphysis menti to the hyoid bone The mylohyoid nerve and artery lie deep to the nodes

Submaxillary nodes—The excision of the submaxillary nodes is

described with removal of the upper nodes of the deep cervical chain (*see* below)

In removing tuberculous nodes the cervical branch of the facial nerve may be injured (*a*) where it lies beneath the deep fascia in the parotid region, (*b*) after it has pierced the deep fascia just below and behind the angle of the jaw (*c*) in the region of the hyoid bone or (*d*) by incisions which pass behind a line running vertically downwards from just in front of the point where the facial artery crosses the mandible to the hyoid bone. (Fig 867)

In order to avoid the cervical branch of the nerve in removing the submaxillary nodes the incision should commence just below and behind the tip of the mastoid process curve downward and forward



Fig 867 —Cervical branch of the facial nerve.

By making the incision well behind the angle of the jaw, below the body of the hyoid, and carrying it forwards in front of the facial vessels the nerve supply to the depressor labii inferioris is preserved in the upper flap.

at least an inch behind and below the angle of the mandible until below the level of the hyoid bone then forward and finally upward towards the symphysis The platysma and skin must not be separated but must be turned up together The cervical branch of the facial nerve leaves the gland between the superficial lower process which lies on the surface of sternomastoid and the deep lower process which extends down along the carotid artery It is best avoided by including the superficial lower process of the parotid gland in the anterior skin flap and dissecting immediately superficial to the capsule of the submaxillary gland when the flap is raised. Even when this technique is employed the nerve is sometimes seen in the loose tissue which intervenes between the superficial lower process of the parotid gland and the posterior edge of the platysma. It is most commonly injured

at the point where it crosses the lower border of the jaw in company with the facial vessels and dissection in this area should be made very carefully The deep part of the nerve may be unavoidably injured when dissecting adherent nodes from the lower part of the parotid triangle The paralysis is rarely permanent because filaments from the mandibular branch of the facial usually supply the depressor anguli oris and upper part of the platysma through the branches to the risorius muscle

The submaxillary and upper deep cervical nodes may be removed through an incision shaped as in Fig 866 8 the vertical limb lying behind the sternomastoid parallel with the anterior border of the trapezius and a horizontal limb carried forwards to just below the symphysis

As a general rule incisions running parallel to the whole length of the sternomastoid are not required for the removal of tuberculous nodes

Excision of the upper cervical nodes.—Enlargement of the nodes of the upper deep cervical chain leads to the formation of a tumour projecting in front of beneath and behind the sternomastoid muscle with a chain of nodes running downward in the posterior triangle.

The incision is started over the mastoid and carried downwards two fingers breadth behind the angle of the jaw to the level of the hyoid bone before it is turned forward. The flap is lifted by dissecting in a plane immediately superficial to the sternomastoid and the capsule of the submaxillary gland. This incision avoids the necessity for dividing the cervical division of the facial nerve which results in facial weakness The external jugular vein running vertically downwards across the sternomastoid and the anterior jugular vein in the front part of the incision are secured, divided, and ligatured and then the incision is carried down to the deep fascia along its whole length The great auricular passing upwards and forwards towards the ear and the small occipital nerve running along the posterior border of the sternomastoid are exposed and need not be divided at this stage though division may be inevitable later When operating for nodes that are not neoplastic it should be a rule to spare all nerves that are not actually involved by the disease process Flaps of skin and superficial fascia are reflected upward and forward and backward and downward until well beyond the superficial limits of the disease. The sternomastoid muscle is defined and an incision is made through the deep fascia at its anterior border and the deep surface of the muscle is dissected off its sheath The spinal accessory nerve is exposed where it enters the deep surface of the sternomastoid from behind the posterior belly of the digastric at a point one inch below the tip of the mastoid, on a level with the lateral mass of the atlas (Fig 868) The sternomastoid branch of the occipital artery runs into the muscle just superficial to the spinal accessory nerve and serves as a guide The nerve is dissected free from the nodes

The sternomastoid is retracted backward and downward and the nodes are exposed as far as possible If the lower and backward limit of the disease is not easily accessible the posterior border of the sternomastoid is defined. The superficial branches of the cervical plexus emerge from behind the middle of the posterior border of the muscle and one of the descending cutaneous branches may be mistaken for the spinal accessory nerve. The spinal accessory usually lies superficial to the nodes at the junction of the upper and middle thirds of the

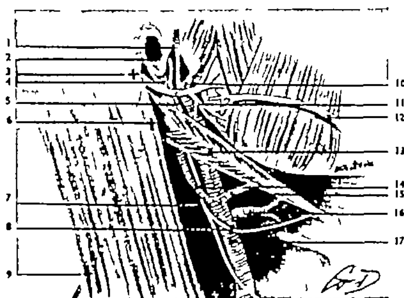


Fig 868 —Facial spinal accessory and hypoglossal nerves.

1 Superficial temporal artery; 2, external auditory meatus 3, surface marking of facial nerve at midpoint of anterior border of mastoid process 4, styloid process; 5, hypoglossal nerve; 6, upper surface marking of spinal accessory nerve, 1 in. below mastoid process and just below transverse process of atlas vertebra; 7 hypoglossal nerve 8, hypoglossal nerve 9 lower surface marking of spinal accessory at posterior border of sternomastoid; 10, internal maxillary artery; 11, facial nerve; 12, Stenson's duct; 13, digastric muscle 14 occipital artery 15, facial artery; 16, lingual artery; 17 external carotid artery

muscle The nerve must be carefully preserved though the cutaneous branches will probably be divided

The muscular branches of the cervical plexus from the 3rd and 4th cervical nerves which run parallel with and just below the spinal accessory nerve should be preserved (Fig 870) They are usually smaller than the spinal accessory but in some cases they are larger and contain most of the afferent fibres to the trapezius The posterior limit of the disease is defined, the sternomastoid is retracted forward, and the nodes in the posterior triangle are dissected off the complexus splenius and levator anguli scapulæ muscles. The sternomastoid is then retracted backward the anterior belly of the omo-hyoid displaced downward and forward and the internal jugular vein is deliberately exposed by dividing the sheath of deep cervical fascia lying over it. The nodes lying free in the posterior triangle are

displaced in front of the sternomastoid If they are not adherent to the wall of the vein they will strip up easily as soon as the sheath is divided As they are dissected upward off the vein the operator will come successively on the ansa hypoglossi the middle and superior thyroid veins the lingual vein and the common facial vein The common facial vein is usually divided in order to free the tonsillar

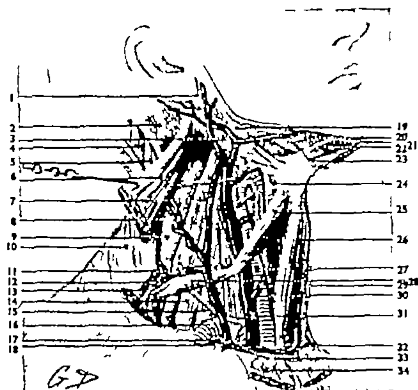


Fig 869 —Muscles and vessels of neck.

1 Temporal vein 2, sternomastoid muscle; 3, posterior belly of digastric 4, complexus; 5, splenius capitis; 6, sternomastoid, 7 external jugular vein; 8, posterior jugular vein; 9, levator anguli scapulae 10, trapezius; 11 transversalis colli vein; 12, posterior scapular vein; 13, posterior scapular artery; 14, scalenus medius 15, scalenus medius; 16, subclavian artery; 17 suprascapular vein; 18, suprascapular artery; 19, stylo-hyoid 20, facial artery 21 facial vein; 22, anterior belly of digastric 23, mylohyoid muscle 24, thyrohyoid muscle; 25, anterior belly of omo hyoid; 26, sternohyoid 27 common carotid artery 28, posterior belly of omo-hyoid; 29 middle thyroid vein 30, scalenus anticus 31 internal jugular vein; 32, communication between anterior jugular veins 33, branch to sternomastoid from suprascapular artery 34, sternomastoid.

lymphatic nodes the hypoglossal nerve lies immediately beneath the common facial vein

The nodes have now to be cleared above and in front The upper part of the sternomastoid is retracted backwards and the nodes are stripped off the internal jugular vein until the lower border of the posterior belly of the digastric is reached the spinal accessory nerve is cleared and the dissection on a more superficial plane carried into the lower part of the parotid gland The main trunk of the facial nerve issuing from the stylomastoid foramen lies above the posterior belly of the digastric but farther forward near the mandible and should never be seen The cervical division of the facial lies on the

parotid gland just beneath the superficial layer of the deep fascia and may be injured particularly if the nodes are adherent. The temporo-maxillary vein is usually divided where it lies in the substance of the parotid on a deeper plane to but below the facial nerve. As one dissects forwards in the upper part of the carotid triangle the nodes lie immediately superficial to the hypoglossal nerve the occipital artery and the external carotid artery



Fig. 870.—Nerves of neck.

1 Facial 2, spinal accessory 3, anterior division of 2nd cervical 4, anterior division of 3rd cervical 5 anterior division of 4th cervical 6, phrenic nerve 7 anterior division of 5th cervical; 8, anterior division of 6th cervical, 9 suprascapular 10 upper trunk of brachial plexus 11, middle trunk of brachial plexus 12, mylohyoid 13, hypoglossal; 14, descendens hypoglossi; 15, anterior belly of omo-hyoid, 16, communicantes hypoglossi 17 anterior division of 7th cervical 18, phrenic 19, lower trunk of brachial plexus.

Removal of the submaxillary nodes.—The facial artery enters the submaxillary gland at the anterior border of the posterior belly of the digastric and stylohyoid muscle and lies on a more superficial plane than the ranine vein and hypoglossal nerve The capsule of the submaxillary salivary gland is removed with the lymphatic nodes in order fully to expose the anterior group of submaxillary lymphatics which lie under the mandible The facial artery should be divided and ligatured if the nodes are adherent to the posterior belly of the digastric and stylo-maxillary ligament The hypoglossal nerve and ranine vein lie deep to the fascia covering the hyoglossus and, therefore escape injury The vein lies superficial to the nerve and serves as a guide to its position. Farther forward the lingual nerve the deep

part of the submaxillary gland with Wharton s duct the hypoglossal nerve and the ranine vein lie deep to the mylohyoid muscle If the deep part of the submaxillary gland is removed Wharton s duct should be ligatured Towards the front of the area the anterior belly of the digastric is exposed and by dissecting beyond this muscle i e between it and its fellow the submental nodes lying on the mylohyoid may be removed

The submaxillary nodes are dissected free from the mandible the

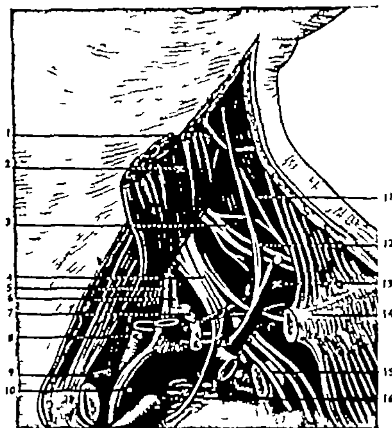


Fig. 871 —Anatomical dissection of left side of neck, showing thoracic duct.

1, Superficial cervical nerve 2, clavicular part of sternomastoid ; 3, descending muscular branches from 3rd and 4th cervical nerves 4 brachial plexus ; 5 vagus nerve ; 6, phrenic nerve 7 thoracic duct 8, common carotid artery 9, anterior jugular vein 10, left innominate vein ; 11 spinal accessory nerve 12, external jugular vein 13, omo-hyoid muscle ; 14 clavicle ; 15, 1st rib 16, dome of pleura.

facial vessels being secured and divided The glandular mass is then removed and any remaining bleeding points are ligatured When the wound is quite dry the layers are sutured with a glove drain through a small incision in the most dependent part of the wound

Excision of the lower cervical nodes.—A curved incision is made commencing over the anterior part of the trapezius 2 in above the clavicle and passing forward and downward to or near the middle line of the neck 1 in. above the sternum If more room is required

the posterior end of the incision may be carried upward and forward along the anterior border of the trapezius The external jugular vein is divided between ligatures at the posterior border of the sternomastoid just before it pierces the deep fascia The incision divides the descending cutaneous branches of the cervical plexus

The upper flap is dissected upward and forward exposing the lower part of the sternomastoid muscle the anterior border of the trapezius and the posterior triangle. The lower flap is dissected down to the clavicle exposing the lower and anterior part of the trapezius muscle. The spinal accessory nerve crosses the upper part of the incision and is dissected free During the operation it may be necessary to divide the anterior fibres of the trapezius and clavicular fibres of the sternomastoid transversely just above the clavicle. The deep fascia is divided transversely at the same level and the nodes immediately come into view Dissection is carried on below and deep to the nodes until the posterior belly of the omo-hyoid is exposed by dividing the fascia which binds that muscle to the clavicle The omo-hyoid is dissected free from the nodes and drawn downward while the anterior border of the trapezius is cleaned and the nodes beneath that muscle and behind the clavicle on the upper part of the serratus magnus are dissected free from the cellular tissue with Mayo s scissors. The suprascapular and transversalis colli veins must be secured

The dissection is now carried upward on the scalenus medius until the upper limit of the disease is reached, and then forward beneath the sternomastoid. The omo-hyoid is retracted upward, and the internal jugular vein is exposed The terminal parts of the transversalis colli and suprascapular veins are ligatured just where they enter the external jugular vein the transversalis colli artery is secured and ligatured and the glandular mass is then turned forward exposing the brachial nerve-trunks Farther inward the phrenic nerve the ascending cervical artery and the lower part of the internal jugular vein will be found lying behind the nodes. The sternohyoid muscle sterno thyroid muscle and the terminal part of the anterior jugular vein lie in front of them. The nodes are dissected off the internal jugular vein until the subclavian vein is exposed The vagus nerve lies behind the internal jugular vein and in front of the vertebral vein and will not be injured if care be taken to keep close to the capsule of the nodes even when they are found to extend behind the internal jugular vein. In dissecting behind the internal jugular the white beaded thoracic duct may be seen and care must be taken not to divide it. If it is accidentally divided the proximal end must be ligatured in order to avoid subsequent collections of chylous fluid in the wound The distal end does not require ligature When all the cervical nodes are removed through two transverse incisions the nodes freed through the upper incision are pushed downward into the lower wound and all are taken away *en bloc*

A glove drain is brought out through a small incision just above the middle of the clavicle

Difficulties in operations on the cervical nodes.—Apart from working through too small an incision these difficulties are usually due to caseation and softening periadenitis leading to adhesion to surrounding structures and spread of the disease to and through the deep fascia with infiltration of the blood vessels nerves and muscles and finally ulceration of the skin with secondary septic infection.

Hæmorrhage.—With a good exposure the arteries are easily secured but venous blood welling up from the depths of the wound may be difficult to control This may invariably be prevented by dissecting the nodes *in situ* as far as possible remembering that traction on the nodes empties the veins and gives them the appearance of bands of fibrous tissue and renders them extremely liable to button holing Whenever possible vessels should be caught and tied no bleeding-point which can be identified should be left unsecured Sometimes there is a general ooze which can only be controlled by temporary pressure For this purpose gauze squeezed out in 1 in 200 000 adrenaline in saline may be used and is helpful several types of absorbable cellulose gauze which may be used for this purpose are now on trial. Only in very exceptional circumstances is it permissible to leave a gauze pack in a neck wound

Dissecting the nodes off the internal jugular vein—Adhesions if present are in most cases outside the sheath of the jugular vein so that by exposing the vessels beyond the diseased nodes they are readily freed by dissecting with a knife or Mayo s scissors. Care must be taken not to dissect in the wrong layer too far from the sheath When the sheath is adherent to the jugular vein the nodes can usually be freed by careful and patient dissection. If they are very firmly adherent before attempting to dissect them away the upper end of the vein beyond the disease should be exposed to minimize the risk of severe hæmorrhage from accidentally wounding it The nodes are then dissected off from below upwards securing branches joining the vein before dividing them and if the nodes are adherent securing with artery forceps the portion of wall just beyond them before cutting them away A small hole in the vein may be closed by a lateral ligature but care must be taken that such ligatures particularly if of catgut are secure Fine silk or linen thread is better for this purpose. If this is doubtful or the hole is too large for a lateral ligature the vein must be tied above and below the opening The inner coats of the vein may herniate through a rent in the outer coats in which case the vein should be ligatured above and below the hernia With experience of the operation the jugular vein need rarely be sacrificed Ligature of the vein and peeling it upward off the vagus carotid and sympathetic make removal of the nodes easier but should not become a routine because apart from the needless sacrifice of an important anatomical structure removal of both veins may have serious consequences to the intracranial circulation if the glands on the other side of the neck are

removed later Sutcliffe* reported that in 250 operations for excision of tuberculous nodes he found it necessary to ligature the vein in only four cases. Watson Cheyne found that removal of a large part of the vein with the nodes was harmless and Stiles† recommends its removal when the nodes cannot be dissected off its wall.

When the nodes are large enough to press on the jugular vein, the collateral circulation through the opposite internal jugular and vertebral veins will be developing before the operation

Difficulty may be experienced in securing the upper end of the external jugular and temporo-maxillary veins in the parotid gland because the bleeding vessels retract into the fibrous stroma and are prevented from collapsing They may be secured by forceps clamping some of the gland tissue and then underrunning the vessels with a suture on a needle before tying

In the lower part of the neck slight wounds of the external jugular vein and the plexus of veins in the supraclavicular fossa the supra scapular transversalis colli and cephalic may cause troublesome hæmorrhage. This may be prevented by securing the lower part of the external jugular between ligatures and picking up the branches to that vessel with forceps before dissecting the nodes

Air embolism.—If traction is made on the nodes and their deep attach ments are divided air may be sucked through a hole in a large vein into the circulation This accident rarely happens because the wound is full of blood by the time the injured vessel has fallen into its depths. After firm pressure with a sponge the wounded vessel must be secured It is a good plan to have a bowl of saline in readiness to pour into the wound should this accident occur If the patient should show severe cyanosis and collapse the vein may be emptied of air by squeezing the chest during expiration (Treves and Hutchinson) When the hissing sound of air entering a large vein is heard the assistant must at once apply pressure on the wounded area with a wet swab The internal jugular vein is compressed above and below the injured area. The assistant then removes the swab and the opening in the vessel is secured with artery forceps and ligatured.

Wounds of the thoracic duct.—The thoracic duct is not often seen during these operations A sudden welling up of clear or milky opalescent fluid into the wound will occur if the duct has been divided—not a very infrequent accident though fraught with no untoward results owing to the number and freedom of the anastomotic channels The ends of the duct should be picked up with pressure forceps and ligatured when this is impossible it may be necessary to pack the wound with gauze for a few days The great majority of cases of wounds of the thoracic duct end in recovery (*see also* p 2062)

Complications.—The degree of general reaction following opera tions on the cervical nodes varies considerably As a rule it is slight

* *Lancet*, Nov 14 1903, ii, 1351
† *Brit. Med. Journ.*, Sept. 12, 1896, ii, 616.

depending on the amount of trauma at the operation There may be a rise of temperature with signs of severe general intoxication from which the patient recovers but fatal cases of generalized tuberculosis have been recorded Such accidents are avoided by operating only where surgical interference is justified after careful local and general examination and by doing the minimum amount of damage during the operation (cutting rather than tearing)

Hæmatoma.—The bleeding is usually venous in origin and easily controlled by firm pressure with the bandage over pads of wood wool Care must be taken to secure all vessels particularly those in the lower part of the parotid and if in doubt about possible oozing to drain the wound If the wound is at all tense the hæmatoma should be evacuated with sinus forceps and a small drain inserted

Exudation from divided lymph vessels.—A certain amount of swelling is not uncommon due to an escape of lymph from the divided lymph channels

In the supraclavicular region there may be an external lymphatic fistula following the division of large vessels such as the thoracic duct. With firm pressure this usually ceases in a few days if not the lower part of the wound should be packed with sterile gauze. In rare cases it may be necessary to explore the wound and secure the oozing lymph trunks (*see* p 2062)

Paresis of the lower lip—Immediately after operation there may be some weakness of the lower lip due to paralysis of the depressor labii inferioris and division of the platysma. This usually disappears in a few weeks but may be permanent The lesion is due to injury of the cervical branch of the facial nerve before it gives off the fibres which unite with the mandibular nerve to supply the depressor labii inferioris

Division of the spinal accessory nerve.—If this nerve is inadvertently divided during the operation it should at once be sutured end to end with the finest catgut or silk

The degree of disability resulting from division of the spinal accessory varies very much. If divided before entering the sterno-mastoid that muscle is partly paralysed and atrophies but movements of the head are not impaired and there is no wryneck Division in the posterior triangle usually causes a partial paralysis of the trapezius

Division of the muscular branches of the 3rd and 4th cervical nerves with the spinal accessory leads to complete paralysis of the trapezius with atrophy The shoulder on the affected side droops the inferior angle of the scapula becomes prominent and rotated towards the spine there is marked deformity and the movements of the shoulder girdle are impaired

Division of the hypoglossal nerve leads to atrophy of the corresponding half of the tongue which is protruded towards the injured side. The nerve is most liable to damage from the point at wh

hooks round the occipital artery to that at which it disappears under the posterior belly of the digastric On the hyoglossus the nerve is covered by fascia and in front of this muscle it lies deep to the mylohyoid muscle It is wonderful how soon the resulting disability is compensated.

Injury to the phrenic nerve.—Stimulation of the phrenic nerve causes spasm of the diaphragm of the same side and division of the nerve leads to paralysis of the corresponding side of the diaphragm. This accident is rarely followed by any noticeable symptoms

Thin stretched scars result from sepsis and from incisions at right angles to the lines of tension in the neck. **Cheloid scars** may result from sepsis or a chronic tuberculous infection of the scar They are not always avoidable X rays will sometimes cure painful or cheloid scars

TREATMENT OF TUBERCULOUS ABSCESSES IN THE NECK

The surgeon must remember that in the majority of cases beneath the deep fascia and muscles there are infected nodes which may be attached to important structures and which can only be dealt with by excision. From this it follows that procedures such as aspiration or incision and curettage have a very limited application in ordinary practice although they may be usefully employed in institutions devoted to the conservative treatment of surgical tuberculosis Such procedures must only be undertaken with the strictest aseptic precautions

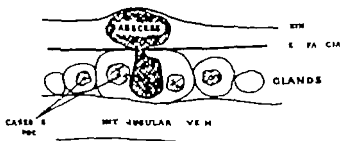


Fig 872 —Diagram of subcutaneous abscess with deep caseating foci. Reproduced by permission of F C. Pybus.

A chronic abscess not involving the skin and obviously fluctuating which is frequently the result of tonsillar infection may be aspirated. The needle attached to the syringe is pushed obliquely through healthy skin from above downwards into the upper part of the abscess cavity A little 2 per cent iodine or 2 per cent solution of gentian violet in water is injected into the cavity The local use of streptomycin by injection into the cavity is on trial and there are some favourable results. The procedure may have to be repeated several times at

weekly intervals It is important to have the needle puncture in the upper part of the abscess If it is placed in the dependent part of the abscess leakage by gravity will increase the risk of infecting the needle track

A subcutaneous abscess with a fixed mass of nodes under the deep fascia may be incised and curetted (Fig 872.) After the contents are evacuated the hole in the deep fascia is found and the caseous node just beneath the fascia is gently curetted away The cavity is lightly packed with gauze soaked in 6 per cent iodine for a few minutes The gauze is removed taking care that the strong iodine does not come in contact with the skin and the wound is sutured If the cavity is complicated by out lying pockets and undermining or if there is much oozing it is better left open and packed with gauze. In two or three days the gauze is removed and the wound either closed by secondary suture or allowed to heal by granulation. If the deeper nodes persist after the abscess is soundly healed it may be necessary to excise them by a properly planned operation

Mortality—By choosing suitable cases and applying to them the appropriate technique the risk of operations on the cervical nodes is negligible Including anæsthetic and so called status lymphaticus deaths the mortality is not greater than that of operations for the radical cure of reducible hernias But each case must be considered on its merits disregarding statistics because there is always the risk of lighting up generalized tuberculosis or of stirring an old focus into activity in all cases where the disease is not primary in and localized to the neck

In 1 800 cases collected from the literature there were two deaths —apparently due to an acute toxæmia—immediately following operation and one four weeks after operation from generalized tuberculosis

End Results.—With more radical methods of operating the liability to local recurrence in the neck has been diminished from 30 per cent to less than 8 per cent. In the older statistics the development of tuberculosis elsewhere following operations on the cervical nodes was not less than 40 per cent. and equal to that in cases not dealt with operatively The later statistics of radical operations are much more favourable not more than 5 per cent. of the cases subsequently developing phthisis or bone-and joint tuberculosis In a recent series of 802 cases in the Essex County Council area traced and analysed by Ronald Reid* the local recurrence rate was 4 per cent and in only 1 per cent traced for an average period of three years was there development of tuberculous lesions elsewhere

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* Personal communication 1949

† Brit Med Journ., 1922, i, 352.

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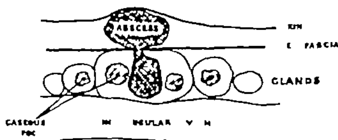


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health but small nodes near operated area 16 alive but other groups of nodes involved 4 alive but with other tuberculous manifestations 2 died of tuberculous disease 6 died from other causes 2 Of 68 cases belonging to the naso-pharyngeal group 60 were perfectly well or greatly improved. Of 20 cases belonging to the mesenteric group only 9 were perfectly well or greatly improved. These figures show that the prospects of cure are best in cases where the enlargement is secondary to infection from the mouth and throat The prognosis after removal of cervical nodes which are secondary to mesenteric infection is not so good but the removal of the nodes before they have broken down and involved the skin may be a valuable adjunct to general treatment.

The results of operative treatment are worst in cases secondary to mediastinal and lung infections Such cases of infection of the supraclavicular glands are usually seen in adults (senile tuberculosis) and operation is rarely justifiable. In the naso pharyngeal group early removal of the nodes before the disease has spread beyond the neck diminishes the liability to bone- or joint tuberculosis later in life

Brian C. Thompson * Assistant Tuberculosis Officer for the County of Durham gives his experience of 195 patients with tuberculous cervical nodes which he observed in 1934. He found that surgical excision gave very bad results In 70 per cent the disease recurred, and in nearly half of the remaining 30 per cent there was persistent sinus formation. In the more chronic types which were aspirated 87 5 per cent developed sinuses Incision or incision with curetting was performed in 70 patients and this is the surgical procedure most favoured by him. He concludes that surgical treatment is unjustified and is not to be recommended. This is much too gloomy a picture of the results of surgery Nearer the truth are the results published by Barrington Ward.† He gives the results of a consecutive list of 188 complete operations in children up to the age of 12. Of these 95 were traced and 89 were personally examined. There was no operative mortality only one required further treatment and all were in perfect health. My own series of 171 patients includes children adolescents and adults In 97 abscesses were opened and curetted in eight sinuses were scraped and in 66 the glands were excised. There were no deaths resulting from operation The results favour complete excision of the whole of the affected area. Sinuses should be excised *en bloc* with the nodes beneath the deep fascia. Abscesses should be excised by dissection before the skin becomes involved.

TREATMENT OF RETROPHARYNGEAL ABSCESSES

There are three types of retropharyngeal abscess —

1 *Secondary to tuberculous disease of the spine* —These are usually median in position and spread through the prevertebral fascia, lying

Lancet, 1936 i, 946.
† *Lancet*, 1937 i, 980.

done the only risk is of concealed or reactionary hæmorrhage, usually the result of an undetected puncture of a vein To avoid accidents it is best to employ general anæsthesia and to make an incision of adequate length Generally it is necessary to dissect out the node taking care to secure the supplying vessels Occasionally nodes will shell out and if this occurs it favours a diagnosis of lymphadenoma. Care must be taken not to puncture or crush the node with holding forceps

REMOVAL OF SECONDARY MALIGNANT LYMPH NODES FROM THE NECK

The technique of all operations on the neck should generally be similar to that described in connexion with tuberculous nodes But in the presence of malignant disease the dissection must be strictly *en bloc* and no attempt must be made to spare invaded structures As a rule the jugular vein must be taken away and the spinal accessory nerve divided. In the rest of this article reference will be made only to special features where the pathology of the disease alters the scope of the operation but not the technical details

Spread of malignant disease from the primary focus to the nodes in the neck.—The *permeation* theory of cancerous metastasis has led to the principle of removing the primary growth with a margin of healthy tissue beyond the estimated area of local infection of the lymphatic plexuses in and around the tumour together with the lymphatic vessels and nodes all in one piece The application of such a principle to all growths which give rise to secondary deposits in the neck formerly led to a great increase in the mortality of these operations and was only justifiable as a routine method if a good immediate and remote prognosis could not be assured. If a free communication is made between the floor of the mouth or the pharynx and the cellular tissues of the neck there is some risk of infection of the neck wound and spreading cellulitis However the risks of operations which open up the tissue planes of the neck to infection from the mouth and pharynx have been very much diminished by antibiotics and are not very significant at the present time. With adequate anæsthesia and correct use of antibiotics in the post-operative period primary healing is often attained and severe spreading infection is very rare indeed.

In cancer of the tongue Butlin s results show that the tissue intervening between the tongue and the nodes is rarely the site of recurrence. The recurrences are met with in the nodes and deeper parts of the tongue and are therefore due to incomplete removal of the nodes or as Cheatle* has pointed out to leaving the deeper muscles of the tongue Dudgeon and Mitchiner† have shown by microscopical examination of the sublingual and submaxillary salivary glands in early and late cases of carcinoma of the tongue lip and floor of the

* *Pract.*, 1905, lxxv, No 2, 623.
† *Lancet*, 1922, ii, 456.

mouth that secondary deposits in these salivary glands are very rare. The deposits are confined to the lymphatic nodes which are in intimate relation with the submaxillary salivary gland. The changes in the submaxillary salivary gland which cause it to become enlarged and hard or merely hard—the condition often regarded as clinical evidence of malignancy—are due to spread of inflammation from the mouth. It seems clear therefore that in cancer of the tongue there is a local permeation of the lymphatic plexuses in the tongue but the larger vessels running from the tongue to the lymphatic nodes are not permeated until very late in the disease. From this it follows that the early glandular invasion is the result of lymphatic *embolism*. The cancer-cells lodge in the nodes by passing along the lymphatic vessels, the latter being free from growth. If the larger vessels running from the tongue to the nodes are not permeated until late in the disease an operation in one, two or three stages leaving behind the tissues between the tongue and the nodes is pathologically sound and justifies the clinical faith in it. Thus in a number of cases it will be possible to diminish the danger of operation by avoiding a communication between the floor of the mouth and the neck without increasing the risk of subsequent recurrence. It is equally obvious that in many other cases of cancer of the tongue and other parts of the mouth, fauces, tonsils and pharynx a free communication must be made between mucous surfaces and the cellular tissues of the neck to get proper access to or to secure wide removal of the primary growth.

The earlier practice was to make a block dissection of the nodes which from the anatomical position of the growth may be expected to become infiltrated. Most surgeons now believe that there is little advantage in dissecting out glands which show no evidence of infiltration. Clinical signs of infiltration may be taken to mean that metastatic deposits have not only reached the glands but have also obtained a footing there. When there is no clinical evidence of infiltration it is possible that deposits have reached the glands but have been destroyed by the natural defences. It is also possible that the glands have offered no barrier to the onward passage of growth. Removal of the glands is not desirable in either of the two conditions last mentioned. If the primary lymph nodes are obviously diseased permeation may have taken place along the smaller interglandular lymphatics and even before the nodes are macroscopically diseased embolic spread to more distant glands may have begun. From the pathological point of view a radical operation on the secondary nodes must be nothing less than the removal *en bloc* of the submental, submaxillary, upper deep cervical and lower deep cervical nodes on one or both sides of the neck. The clinical fact that the patients usually die before the glandular metastases have spread beyond the neck is in favour of these extensive neck dissections. A palliative operation on the neck is justifiable if there is a prospect of saving the patient from the discomfort and misery of a foul-smelling external fistula due to broken-down malignant disease in the nodes.

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mouth that secondary deposits in these salivary glands are very rare The deposits are confined to the lymphatic nodes which are in intimate relation with the submaxillary salivary gland The changes in the submaxillary salivary gland which cause it to become enlarged and hard or merely hard—the condition often regarded as clinical evidence of malignancy—are due to spread of inflammation from the mouth It seems clear therefore that in cancer of the tongue there is a local permeation of the lymphatic plexuses in the tongue but the larger vessels running from the tongue to the lymphatic nodes are not permeated until very late in the disease. From this it follows that the early glandular invasion is the result of lymphatic *embolism* The cancer-cells lodge in the nodes by passing along the lymphatic vessels the latter being free from growth If the larger vessels running from the tongue to the nodes are not permeated until late in the disease an operation in one two or three stages leaving behind the tissues between the tongue and the nodes is pathologically sound and justifies the clinical faith in it Thus in a number of cases it will be possible to diminish the danger of operation by avoiding a communication between the floor of the mouth and the neck without increasing the risk of subsequent recurrence It is equally obvious that in many other cases of cancer of the tongue and other parts of the mouth fauces tonsils and pharynx a free communication must be made between mucous surfaces and the cellular tissues of the neck to get proper access to or to secure wide removal of the primary growth

The earlier practice was to make a block dissection of the nodes which from the anatomical position of the growth may be expected to become infiltrated Most surgeons now believe that there is little advantage in dissecting out glands which show no evidence of infiltration Clinical signs of infiltration may be taken to mean that metastatic deposits have not only reached the glands but have also obtained a footing there When there is no clinical evidence of infiltration it is possible that deposits have reached the glands but have been destroyed by the natural defences It is also possible that the glands have offered no barrier to the onward passage of growth Removal of the glands is not desirable in either of the two conditions last mentioned If the primary lymph nodes are obviously diseased permeation may have taken place along the smaller interglandular lymphatics and even before the nodes are macroscopically diseased embolic spread to more distant glands may have begun From the pathological point of view a radical operation on the secondary nodes must be nothing less than the removal *en bloc* of the submental submaxillary upper deep cervical and lower deep cervical nodes on one or both sides of the neck The clinical fact that the patients usually die before the glandular metastases have spread beyond the neck is in favour of these extensive neck dissections A palliative operation on the neck is justifiable if there is a prospect of saving the patient from the discomfort and misery of a foul-smelling external fistula due to broken-down malignant disease in the nodes

The operation of removing all the nodes *en bloc* though ideal pathologically cannot always be carried out with advantage to the patient or to the surgeon. When a patient is a good surgical risk and consents to a two- or three-stage operation it should be done.

In early cases before the nodes are obviously diseased, the surgeon may feel that such an extensive operation is unnecessary and may confine his dissection to the removal of the primary lymph nodes and the deep fascia with ultimate good result. In more extensive cases where a bilateral node dissection is called for the patient may be unwilling to submit to a three- or even a two-stage operation Many patients would be precluded altogether from an operation on the nodes on account of their poor vitality if removal in three or even two stages became the minimum standard of operative procedure In such circumstances experience sometimes justifies less radical operations which from the pathological point of view are incomplete and from the clinical side merely palliative. None the less when the malignant nature of the primary growth is proved the surgeon should not be deterred and should carry out the complete radical removal of the lymph nodes at least on the side of the lesion. Whether the neck dissection should be bilateral depends on the position and extent of the primary lesion as well as its response to treatment and is a matter to be decided in each individual case

Block dissection of the lymphatic system of the neck (Crile s method) is carried out when required, on the same lines as the Halsted operation for cancer of the breast The operation should be deferred until a month after the primary growth has been successfully treated.

A tri radiate incision should be used. The vertical component extends from the mastoid process to the clavicle at the point where the posterior border of the sternomastoid meets it The horizontal component starts at the point of the chin and runs backwards and downwards to the middle of the vertical incision. In a heavily built patient the vertical incision may require to be extended backwards for a short distance along the clavicle to give good access to the posterior triangle. The skin is reflected over the entire area of the field. The sternomastoid is divided at its attachments and removed. The internal and external jugular veins are secured and divided between ligatures at the base of the neck. The dissection is then carried from below upward into the deep plane of the neck working first at the sides and then posteriorly carrying upward all the fascia muscles veins fat and connective tissue with the lymph nodes. The upper end of the internal jugular vein is ligatured. Some surgeons prefer to tie the upper end of the internal jugular first so that dissection is not hindered by the distended vein.

Only one side of the neck should be operated upon at a time. If the other side has to be done later the internal jugular vein must not be removed on both sides. A drain is put in the lower angle of the wound For some time after the operation there may be œdema of

the lower part of the face There is also a temporary lower facial palsy

This must always be regarded as an operation of great magnitude and especial care must be taken to avoid blood loss air embolism and infection Time is necessary and two hours or more is not too long to spend in carrying out the work efficiently In the hands of experienced operators the primary mortality rate has been about 3 per cent. The late results are encouraging when compared with the other methods available In 197 cases where the nodes where proved microscopically to be invaded by growth at the time of operation 33 per cent survived and were found to be without recurrence at the end of 10 years.*

Further Notes on the Operation

The object of the intervention is to expose and remove *en bloc* the whole of the tissues of the neck which may harbour lymph nodes and tissue This means that the exposure must be very thorough and must extend from the base of the skull to the clavicle as far as the middle line and posteriorly over the edge of the trapezius In order that the patient may tolerate such an interference with as little upset as possible it is necessary that the general condition should be good and it is essential that adequate preparation should be made to attain that state before the operation is carried out. At the actual operation it facilitates matters if the patient is placed on the table with the whole of the neck thoroughly exposed and extended the head being turned well towards the opposite side and the shoulder slightly raised. In order to expose the field completely the skin flaps should be dissected back over the whole area as the first step The flaps should be carefully protected with moist gauze which should be kept warm A temporary stitch here and there tacking the edges of the flaps to neighbouring areas or to towels is probably the best method of keeping the flaps out of the way while the dissection proceeds.

Although it is wise to know the patient s blood group and to be prepared to give a transfusion during the course of the operation it should be the object of the surgeon so to conduct the interference that this measure will not ordinarily be necessary At all stages of the operation the greatest care must be taken to avoid unnecessary hæmorrhage and so far as ever possible even quite small vessels are better caught before being divided or should be caught immediately afterwards as the accumulated blood loss from such a large area may be considerable. On the subject of control of hæmorrhage it is well to state that the writer has never used a clamp or temporary ligature on the common carotid nor is it thought to be necessary The facial artery is ligatured as it enters the capsule of the submaxillary gland and the occipital branch where it crosses the internal jugular vein It is sometimes convenient to divide the superior thyroid artery with its accompanying veins Few surgeons today remove the external carotid in a radical dissection of the glands of the neck

* W R. Douglas, Christie Hospital, Manchester Personal communication not yet published.

It is part of the object of the operation, as in all malignant cases to take away the platysma. The area having been demarcated the next step is to incise down to the deeper tissues at the confines of the reflected skin. Dissection should be by sharp cutting and not by gauze stripping The deeper dissection is most conveniently commenced below and as an early step both edges of the sternomastoid should be exposed and identified just above the clavicle. The lower attachment of the muscle should be divided right across at this stage of the interference. This division is best made about ½ in. above the clavicle so that those small vessels which enter the muscle can be easily caught and later ligatured if the division is made right down on the bone it is much more difficult to catch these vessels After opening the cellular tissue just above the clavicle the internal jugular should be exposed and gently lifted from the underlying structures. It is convenient to apply a clamp right across this vessel to act as a tractor and to draw the vein gently away from the deeper structures Ligatures should be applied both above and below this clamp a sufficient portion of vein being left to hold the ligature securely The clamp is then removed and the vein cut across through the crushed area. If there is any doubt about the security of the ligatures then either cut end of the vein should be caught in forceps and held up so that second ligatures can be securely applied to the ends. At a much later stage the upper end of the jugular is similarly exposed doubly ligatured and divided. Occasionally the vein is inadvertently torn close up to the base of the skull so that it is impossible to apply the ligature. In these rare circumstances the bleeding can be safely dealt with by packing a narrow strand of gauze firmly down to the area. The pressure in the vein is low and this measure will easily arrest bleeding but it must be remembered that in these circumstances the gauze cannot be safely removed until the end of about a week for at any earlier stage it is highly likely that bleeding will re-start if the gauze is ever so gently removed. Even at the end of a week there is some little risk and, therefore the gauze should be very gently loosened by drawing on its edges and if there is the slightest sign of bleeding the surgeon must stop the process and leave the gauze for another 48 hours or longer before it is finally removed.

Carrying the dissection upwards from below both bellies of the omo-hyoid are exposed and may be divided and completely removed. It is not necessary to remove the digastric muscle. Unfortunately it is essential to divide the spinal accessory nerve but equally unnecessary to divide the hypoglossal and great care should be taken not inadvertently to crush it with forceps. If it is crushed and the clamp is removed the nerve will slowly recover if divided end to-end suture should be done there and then. At the lowest part of the neck especially on the left side there is some risk of injury to the lymphatic duct Should this occur the wound will flood more or less quickly with chyle the milky nature of which is quite unmistakable. The proper course is to soak up the fluid so that the leaking point may be

seen The latter should then be caught in forceps and securely ligatured It is quite unnecessary to attempt repair of the duct or to think of re-implanting it into one of the great veins The important question of entry of air into the veins is dealt with on p 2060

While the operation is proceeding any part of the large area which is not actually being worked should be kept covered with gauze to prevent contamination to keep the parts moist and to do something to conserve the body heat When the dissection is completed the whole wound should be exposed and very carefully examined for bleeding points which must then be dealt with by ligature or by under pinning with suture-ligatures The writer has not found that any of the hæmostatic substances are reliable and thinks they are much better avoided It is wise to provide adequate drainage and this is best done by a softened rubber tube of about ¼ in diameter or by a folded strand of rubber sheeting rather less than ½ in wide As the patient will probably be sitting up during convalescense such a drain will be more effective if it is brought from near the lowest part of the wound Care must be taken that its deep end does not lie in contact with the great vessels. It should be removed in four days.

Before the edges of the incision are approximated by skin suture care should be taken to establish contact between the skin flap and the deeper tissues by a tacking catgut stitch applied here and there Careful suture of the skin-edges will then complete the operation In some cases the central corners of the flap may necrose and it is difficult to avoid this but if they are obviously embarrassed so far as circulation is concerned it may be a wise plan to snip off prominent corners before completing the suture. A very ample dressing of firm wool should be applied in order to keep up slight pressure on the flap and to act as a support or splint for the neck In some few cases where the nodes are considerably invaded it may be found that the disease has gone beyond the capsules and that there is an area of infiltration In these circumstances such an area of infiltration cannot be effectively removed by dissection and may be treated by the insertion of radium needles or by some other method of irradiation

The surgeon should take care to cover the area by careful arrangement of the skin flap and should not be tempted to leave such a wound open with the mistaken idea that irradiation will be more effective.

RADIOTHERAPY OR RADIATION IN THE TREATMENT OF THE LYMPH NODES

Some surgeons believe that even after satisfactory removal of the node-bearing areas it is well to use external radiation as a measure of prophylaxis This should not be undertaken until the incisions are soundly healed and seldom sooner than a month after operation

When malignant disease has extended through the capsule of one or more glands and invaded the surrounding tissues operation is not likely to be successful Direct invasion of the internal jugular vein

is not a contra indication to operation and localized invasion of the skin does not always affect the prognosis adversely Fixation to the deep muscles or to the pharynx or to the common or internal carotid is a contra indication to operation In these circumstances tele-irradiation should be used if it is available and good palliative results are sometimes obtained When tele-irradiation is not available interstitial irradiation may be used provided that the operator has sufficient experience in technique and dosage. Interstitial irradiation carried out with insufficient knowledge may make the patient very much worse.

THE SURGERY OF THE THORACIC DUCT

The thoracic duct is the connecting link between the small intestine and the venous system. It ascends through the superior mediastinum into the neck. At the level of the sixth cervical vertebra it arches outwards and forwards above the pleural sac and the first part of the subclavian artery (Fig 871) The danger of wounding the duct is increased by the fact that its arch may be over two inches above the upper border of the sternum and touching the thyroid gland. The duct passes in front of the vertebral artery and vein the roots of the inferior thyroid transverse cervical and suprascapular arteries the inner border of the scalenus anticus muscle and the phrenic nerve. It passes behind the carotid sheath and its contents and joins the commencement of the left innominate vein. Shortly before its termination it receives the lymph ducts coming from the left side of the head and neck from the left arm and the left mamma. A pair of valves formed of semilunar folds of the inner coat is situated at the orifice of communication with the innominate vein Sometimes the duct divides one branch emptying into the right subclavian vein. It may end in the left internal jugular vertebral or subclavian veins and very rarely in the vena azygos major The outlet of the duct may be double and sometimes there are several openings into the vein forming a delta. This explains why injury to one branch causes no serious harm if the damaged branch is ligatured. There are often anastomoses with the azygos vein in the chest and with the duct on the right side and therefore it is easy to understand why simple ligature of the main duct when it has been wounded produces no harmful result.

Wounds of the Thoracic Duct

Injury to the thoracic duct is an occasional complication of operations on the left side of the neck The immediate result is usually a sudden welling-up of clear or milky opalescent fluid into the wound but frequently the chylorrhoea has not developed for some hours or even days after the operation. In these cases probably the wound has been a slit which has been closed temporarily by blood clot The amount of chyle which escapes may be enormous Ingestion of food is followed by a marked increase of the discharge. The patient

complains of hunger and thirst In most cases the general condition remains unimpaired However there may be emaciation and progressive loss of strength weakness of the pulse and even loss of consciousness There is some fever probably due to absorption of nucleins and albumens Patients usually make a slow recovery due to the gradual closure of the fistula and the dilatation of the anastomotic channels between the ducts of the two sides and the communications in the thorax

Treatment.—Ample clinical experience has shown that the best plan is to apply a ligature as with a divided or torn vessel Fine chromic catgut should be used as plain catgut may absorb too quickly and further leakage may result. Gauze packing must be used when the point of injury cannot be controlled by ligature the wound being firmly packed with dry ribbon gauze Only small quantities of fatty food are allowed until the collateral circulation is established Thirst is allayed by continuous saline infusion The gauze is not touched until the fourth day when it is merely loosened removal being com pleted at the end of a week

Other methods such as suture of the duct or its implantation into a neighbouring vein are unnecessary and are now of academic interest only

Sometimes leakage from the thoracic duct is not observed at the time of operation but the escape of chyle from the wound may be noticed some days later or after the wound has healed there may be a considerable collection of fluid which on relief is found to be milky Such a secondary fistula will usually close spontaneously if drainage on to the surface is free and if pressure is carefully applied to keep the tissues in contact If healing does not occur the incision should be re-opened and the leaking area tamponnaded with gauze soaked in tincture of iodine to set up reaction Secondary ligature of the duct has occasionally been necessary but should not be attempted in the first instance because of the disturbance of the parts necessary to expose the actual leaking point

TREATMENT OF OTHER CERVICAL GROWTHS

Lympho-sarcoma, branchiogenetic carcinoma, and lymphadenomatous growths.—When primary in the neck lympho-sarcoma remains localized for a considerable time and the patients usually die from cachexia before extensive metastases have formed. Removal of such growths in their early stages followed by appropriate use of radiation under guidance of an expert is well worth undertaking

Lympho-sarcoma branchiogenetic carcinoma and lymphadenomatous tumours are best excised by block dissection through an ample incision over the sternomastoid muscle which is removed together with the nodes and fascia.

Advanced malignant disease.—In some of these unpromising cases it may be considered feasible to undertake what can only hope to be a

palliative removal. Of course this can only be attempted absence of metastases or extension beyond the neck. The ski be much involved and may be ulcerated or there may be deep with other evidence of involvement of deep structures. Such ope are always hazardous and uncertain in result but the relief of pa discomfort may make them worth while. The only way to tack problems is to use ample unhampered incisions without th regard for cosmetic consideration In the deeper dissectic most important point is first to expose the great vessels beyo confines of the mass usually below the mass. A temporary li or rubber tube around the carotid is wise in spite of the risk (*see* p Such a ligature should not be tied until the necessity becomes ap but it is an essential precaution to have it in place at an early A thin rubber tube is very convenient for it may simply be drawn the vessel to the point of occlusion and temporarily secured artery forceps If necessary any or all of the structures o side of the neck may be removed and no evil consequences be feared from sacrifice of considerable portions of both vag sympathetic. Portions of the thyroid or of the pharynx or may have to be ablated. Sometimes it is not possible to car immediate repair of these structures in which case the mar any opening necessarily left should be sutured to the skin or a g part of the wound may be left open and lightly packed with a tube being left in the pharynx or passed as required for fe The wound must be kept as free as possible from mucus and dis by suction and frequent changing of the gauze. The use of pe and the sulpha drugs now plays a great part in the treatment o cases. Any sacrifice may be considered worth while if it is poss get beyond the confines of the growth The only real contra ind is diffuse infiltration where malignant growth has burst throug the cellular tissue. In the latter circumstances the surgeon s be able to retire gracefully and it is a comfort to be able to do s the common carotid intact. Sometimes where much skin has b be sacrificed it is not possible to draw the wound edges tog and approximation can only be obtained at the expense of great te which may be most uncomfortable for the patient, may emb breathing and is liable to be followed by large areas of skin ne That being so it is better to leave even a large part of the wound and lightly packed with gauze charged with a reliable antis If there is little or no oozing petroleum jelly gauze may be empl though if hæmostasis is an object the greasy gauze will not s Such wounds eventually heal by granulation sometimes in a surp way but a secondary plastic repair may be necessary

Lymphangiomatous tumours, hæmangiomata, blood-cysts, or hygroma.—These growths occur as congenital cystic swe containing yellow green, or brown fluid or blood and are u multilocular Operative treatment is indicated when the cyst

increasing in size or producing symptoms such as dyspnœa or difficulty in swallowing Owing to their connection with the lymphatic system the cysts may extend into the intermuscular planes and the muscles so that complete removal by dissection without damage to important structures is impossible

When excision must be undertaken the main group of cysts is removed by dissection and the wound wiped out with 6 per cent iodine to obliterate by cicatrization the deeper parts lined with endothelium The iodine must not be allowed to come in contact with the skin

Thyroglossal cysts and fistulæ and accessory thyroids are considered on pp 2071 2072.

Tumours of the carotid body—These are situated in the middle of or just deep to the bifurcation of the common carotid artery in close relation with the hypoglossal and vagus nerves and the sympathetic chain The majority of the tumours are innocent and even the malignant ones do not give rise to metastases They usually exhibit transmitted pulsation but occasionally they lie deep and push the vessels forward They are movable laterally but not vertically They should be approached by an ample incision along the anterior border of the sternomastoid muscle The internal jugular vein is divided between ligatures below the tumour and dissected upward These tumours bleed very freely and it is usually necessary to ligature the external carotid artery at its origin and to excise a portion of the vessel in continuity with the tumour

In some cases the tumour is removable only if combined with resection of the carotid bifurcation a drastic necessity which is followed by hemiplegia in 20 to 30 per cent of cases In such circumstances the tumour should be left *in situ* until a biopsy proves it to be malignant and determines that the risk of complete removal must be taken Efforts have been made to obliterate the common carotid gradually in the hope of diminishing the risk of hemiplegia (*see* pp 562 568 ligature of the common carotid) Division of the hypoglossal nerve may be unavoidable When practicable the vagus should be dissected from the tumour but both it and the symphathetic may have to be divided and a part removed. If the symphathetic is resected with the tumour slight miosis and enophthalmos will ensue. If arterial grafts are available the risks of arterial resection are much diminished.

Branchial cysts, dermoids and fistulæ arise in the neck from persistence of the whole or part of the branchial clefts **Cervical sinus, or branchial fistula,** is due to persistence of the whole or part of the second branchial cleft so that the track passes between the internal and external carotid arteries in intimate relation with the superior laryngeal nerve and ends in the pharynx at the fossa of Rosenmüller

Cysts are dissected away through a transverse or oblique incision over the swelling It is essential to remove every bit of the wall

Some surgeons deliberately open very large cysts and insert a as a guide to the dissection of their deepest part To facilitate re the area may be injected with 2 per cent gentian violet solu water

The sinuses are treated in three ways (1) The track is di out completely As the sinus usually extends from the lower of the neck to a point level with or above the bifurcation of the artery it is necessary to use either a long vertical incision or more transverse incisions at different levels The latter metho better end results and is less disfiguring but it makes the op rather more difficult. (2) The lower part of the track is di away and twisted off from its deeper connection to the ph (3) In the very rare cases where the connection with the phar patent the greater part of the sinus is dissected free a probe is through into the pharynx, and the remainder of the sinus is s to the probe with a ligature The probe is then withdrawn fr pharynx. The sinus is thus turned inside out and may be cut of its attachment to the pharynx.

Sequestration dermoids, sebaceous cysts, and lipomat removed through incisions in or parallel with the creases in th Encapsuled lipomata shell out easily through a comparatively incision. Diffuse lipomata, which usually occur on the back neck demand free incisions for their removal

Cervical auricles.—These are generally represented by ren of cartilage buried in the superficial tissues Removal is not di but the necessary incisions should be made obliquely in the n folds

Abscesses, even though acute should be opened by oblique in following natural folds as the resulting scars are then muc conspicuous

Ludwig s angina may be regarded as an exception for this is so serious and acute that cosmetic considerations have to be garded A deep incision over the centre of a line from the symph the body of the hyoid is essential supplementary incision ma be required and the deep fascia must either be directly incised o open by Hilton s method

Operations on the vessels and nerves of the neck will be fou pp 593 and 566 of Vol. I

CHAPTER XXXVII

THE SURGERY OF THE THYROID, PARATHYROID AND THYMUS GLANDS

By SIR GEOFFREY KEYNES

Morphology —The thyroid parathyroid and thymus glands all three belonging to the endocrine system of the body are derived from closely related embryonic rudiments The thyroid is believed to be developed from three sources—the median portion comprising the pyramidal lobe isthmus and parts of the lateral lobes from an epithelial down growth afterwards indicated by the foramen cæcum on the base of the tongue the lateral portions forming the greater part of the lateral lobes, from the entoderm of the ventral parts of the fourth pharyngeal pouches The so-called thyroglossal duct is a morphological remnant representing the original connection of the isthmus of the thyroid with the back of the tongue at the site of what becomes the foramen cæcum

The parathyroid bodies are derived from the entoderm of the dorsal parts of the third and fourth pouches the superior body in association with the lateral thyroid rudiments from the fourth the inferior with the thymic rudiments from the third. The inferior parathyroid being thus carried down with the developing thymus comes to lie below its fellow although its origin was at a higher level. These facts help to explain the frequent anomalies in the position of the parathyroids which may be found at almost any point of the course of descent from near the base of the skull to the pericardium

The thymus gland is regarded as being derived from both entoderm and ectoderm and thus contains two different epithelial elements. The entoderm is stated to come from the ventral portions of the third pharyngeal pouches and the ectoderm from the buried epithelium of the precervical sinuses. The thymic rudiments from each side meet and are united by connective tissue but do not fuse

THE THYROID GLAND

Anatomy —The thyroid gland consisting of lateral lobes isthmus and pyramidal lobe embraces the larynx and upper end of the trachea the isthmus covering the second third and perhaps the fourth rings The lateral lobes are more or less conical in shape with the apex upwards and extend on either side from about the middle of the ala of the thyroid cartilage to the sixth tracheal ring The pyramidal lobe is often absent and when present represents the lower part of the

thyroglossal tract. It is very variable in size extending from the upper border of the central part of the isthmus towards the hyoid bone usually slightly to the left of the midline and lying on the cricothyroid muscle and the thyroid cartilage

The superficial surfaces of the thyroid lobes are covered by the sternothyroid muscles. The sternohyoids and more laterally the superior bellies of the omohyoids lie superficial to the sternothyroids

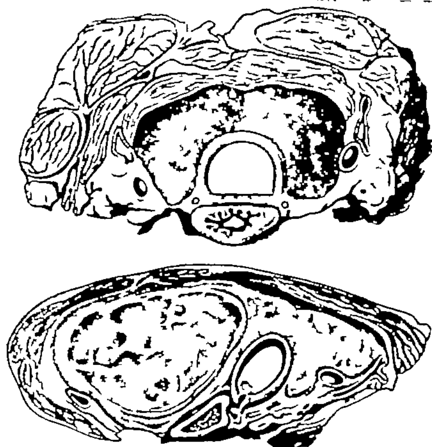


Fig. 873.—Transverse sections through the neck at the level of the thyroid isthmus (post-mortem specimens)

Top Normal, showing relation of thyroid to pretracheal and sternomastoid muscles in front, vessels laterally and oesophagus behind. *Bottom* Abnormal, showing displacement and deformation of the trachea by a large thyroid adenoma in the left lobe.

and are covered in part by the sternomastoid muscles. The sternohyoids and sternothyroids are known as the pretracheal or strap muscles. The mesial borders of the pretracheal muscles commonly meet in the midline over the thyroid isthmus but the omohyoids lying farther back are not usually seen in operations on the thyroid gland (Fig 878)

The postero-lateral surface of each thyroid lobe is related to the carotid sheath and lies in front of the common carotid artery The jugular vein lying more laterally only comes into relation with the thyroid gland when this is enlarged. The posterior border of each lobe

has extremely *important relations* It passes deeply as a wedge between the carotid artery and the trachea. On the right side it may reach the longus cervicis muscle on the left it is in contact with the œsophagus In the angle between the trachea and the œsophagus lies the recurrent laryngeal nerve which is therefore in close proximity to the posterior border of the thyroid gland for a considerable distance

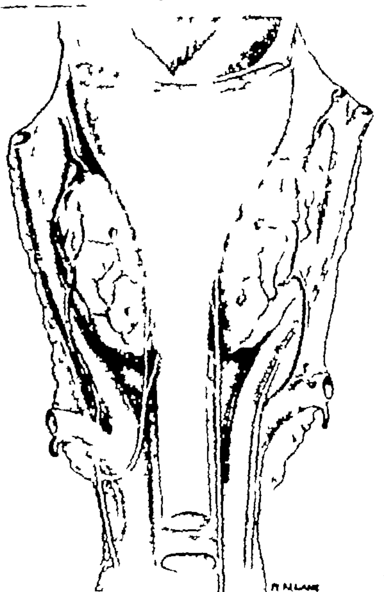


Fig. 674.—Dissection of the structures in the neck from behind, showing posterior margins of thyroid lobes, parathyroid bodies, thyroid arteries and recurrent laryngeal nerves.

until it passes beneath the inferior constrictor The medial surface, which is *moulded over the trachea and the cricoid and thyroid* cartilages also covers the inferior constrictor muscles and the posterior part of the crico-thyroid muscles with its external laryngeal nerve. The parathyroid bodies are also usually on or close to the posterior

borders of the thyroid lobes the upper one being near the apex lower one in close relation to one of the branches of the inferior thyr artery (Figs. 874 and 875)

The thyroid gland is extremely vascular having two main ves of supply on either side The superior thyroid artery descends fr the external carotid artery to the apex of the lobe where it divi into three or more branches. The largest of these is often conspicuo

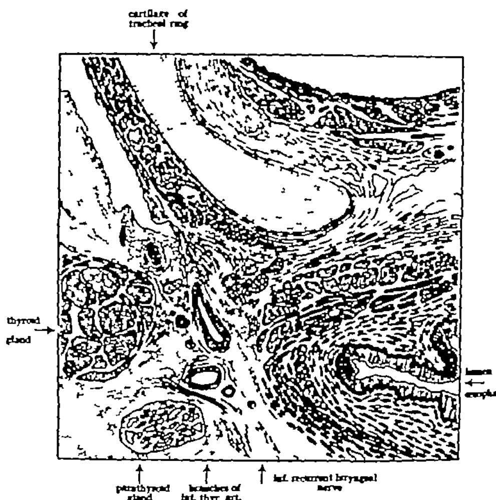


Fig. 875.—Drawing from a microscopic section (enlarged) through the area at the angle between trachea and oesophagus. Structures indicated by arrows.

passing medially from the apex to the isthmus and supplies the anter part of the gland The others pass to the lateral and posterior pa of the gland and anastomose with branches of the inferior artery T inferior thyroid artery arises from the thyro-cervical trunk (thyro axis) under cover of the internal jugular vein passing upwards front of the medial border of the scalenus anterior it turns inwards about the level of the cricoid cartilage lying on the longus cervi

muscle deep to the carotid sheath (Fig 874) At operations on the thyroid gland the artery is found below this level the larynx having been carried upwards by the extension of the head on the operating table The artery divides into two or more branches which enter the postero-lateral border of the lateral lobes at the so-called hilum of the gland As these branches reach the gland the recurrent laryngeal nerve may lie behind between or in front of them The thyroid veins form a plexus on the surface of the gland from which arise superior middle and inferior channels The superior veins accompany the artery to reach the internal jugular The middle thyroid veins are extremely variable. There may be several crossing the carotid artery to join the internal jugular or there may be one large vessel Often there is none The inferior thyroid veins arise from the plexus on the isthmus and pass into the thorax on the front of the trachea and usually end in the left innominate vein

The thyroid gland is enveloped by the pretracheal layer of the deep cervical fascia which is attached above to the cricoid cartilage The gland must therefore always move with the larynx The gland has its own fibrous capsule and the arteries and veins ramify between this and the enveloping fascia.

Physiology—The activity of the thyroid gland is controlled by a thyrotropic hormone from the anterior lobe of the pituitary Its secretion known as thyroxin is stored in the iodine-containing colloid material found in the epithelial vesicles of which the gland is composed An over-activity of the gland is accompanied by the symptoms of thyrotoxicosis with or without the exophthalmos which can be produced independently by the pituitary secretion Under-action of the thyroid results in a general slowing of metabolic processes in the body together with the clinical condition known as myxœdema. Surgical operations on the thyroid aim at reducing either its size or its activity or both with due regard to the normal needs of the body so as to avoid a surgically induced myxœdema. The amount of tissue to be removed cannot be prescribed by any rule It can only be judged according to the surgeon s experience and his knowledge of the needs of the individual patient.

CONGENITAL ABNORMALITIES

Thyroglossal Cysts and Fistulæ

The origin of the central portions of the thyroid gland from the *anlage* at the foramen cæcum necessarily results in a morphological connection between this region and the isthmus of the gland. Normally this thyroglossal tract undergoes complete atrophy leaving only a long fibrous cord, or at most a shorter fibrous cord from the base of the tongue to the apex of a pyramidal lobe lying on the larynx Not infrequently however this tract persists in whole or in part as a thyro-

glossal duct which has a definite lumen lined with ciliated colum cells If the lower part only persists it is apt to form a thyroglo *cyst overlying the cricoid or hyoid cartilages in or near the midli* It is never safe however to assume that the cyst which is ea dissected away from the larynx is the sole remnant of the thy glossal tract The operative treatment must indeed always be dra *and must aim at the extirpation of the whole tract* A high co incision is made above rather than over the cyst. When the cyst been dissected away from its bed it will be found that its upper en attached by a strand of tissue to the body of the hyoid bone T *relation of the thyroglossal tract to the hyoid bone is variable an* may pass in front of or through bone instead of doubling in front and then behind it as in Fig 8 The central part of the hyoid b should therefore be defined a its surfaces cleared with a rug from muscular attachments. T *bone is then cut through on eit* side with bone-forceps so that a s tion of the central part is remov and the thyroglossal tract follow *upwards above the hyoid throu* the muscles at the base of the tong When the surface of the tongue the foramen cæcum is reached, t *tract is clamped and tied withc* making an opening into the mout The anæsthetist can help in c fining the situation of the foram *cæcum by inserting his finger* the mouth. In this way the wh tract can be removed in one pie

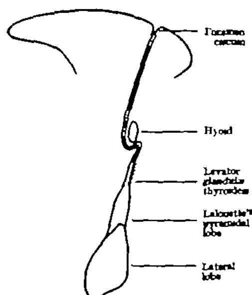


Fig 876.—The course of the thyroglossal tract.
(From Treves' Surgical Applied Anatomy Cassell)

If anything less than this is done as a routine formation of a troub *some fistula will follow in a considerable proportion of the patien* Secondary operations may be very difficult

If instead of a cyst there is a fistula in the first place, situated or near the midline the skin incision should be made to encircle t opening When this is separated from its surroundings the thyr glossal tract leading from it may be extirpated as already describe Separation from the surrounding parts can be effected by blunt di section with the tract slightly on the stretch but great care must b taken not to tear it across.

Aberrant Thyroids Lingual and Cervical

Occasionally the thyroid *anlage* at the foramen cæcum may fail t grow downwards developing instead into a mass of thyroid tissue at th

base of the tongue or in the submental region This is unlikely to call for surgical treatment unless it is so large as to interfere with breathing or swallowing Surgical excision may then be considered but the possibilities of treatment by radio-active iodine isotopes should first be investigated

If the mass has become cystic radio-active iodine will not be effective and lingual thyroids of this kind must be excised Those that project on the surface of the tongue may be removed through the mouth The jaws are held open by a gag and the tongue is drawn out as far as possible and held by two salmon gut sutures passed through its substance on either side of the proposed incision A wedge-shaped area including the cyst is then excised between the sutures The position and amount of all thyroid tissue can be accurately estimated by means of radio-active iodine isotopes if this investigation has failed to detect any thyroid in the neck no attempt should be made to remove *all* the thyroid tissue in the tongue since if this were successful myxoedema would result. There will be considerable bleeding from the walls of the cavity formed by the excision This will be controlled as the cavity is obliterated by drawing the sides together with deeply placed catgut sutures Preliminary ligature of the lingual arteries (*q v*) may be a wise precaution.

Thyroid cysts that are more deeply buried in the tongue should be approached from below through a collar incision at the level of the hyoid Vertical or oblique incisions should never be made in this region as the resulting scar may cause serious deformity The upper skin flap is dissected free and the median mylohyoid raphe exposed and divided vertically The geniohyoid muscles are separated and the cyst or thyroid mass extracted from the substance of the tongue by a process of enucleation and dissection An assistant may make this easier by a finger in the mouth pressing on the mass from above. The bleeding cavity among the muscles is then obliterated by a succession of catgut sutures It is advisable to provide drainage through one end of the skin incision for 24 hours There may be considerable swelling of the tongue after this operation but it subsides in about 48 hours.

Masses of aberrant thyroid tissue in the neck are seldom seen The tumours formerly classed under this name are now generally regarded as being metastatic thyroid carcinomas.

THYROIDITIS

Bacterial infections of the thyroid gland are uncommon and when they occur should not often demand surgical treatment. An acute infective thyroiditis should be treated in the first place by antibiotics and suppuration should hardly ever occur If it does the pus must be evacuated according to general surgical principles The incision will be made wherever the pus seems to be pointing and should always be transverse so that it may heal with minimal scarring

glossal duct which has a definite lumen lined with ciliated columnar cells If the lower part only persists it is apt to form a thyroglossal cyst overlying the cricoid or hyoid cartilages in or near the midline. It is never safe however to assume that the cyst which is easily dissected away from the larynx is the sole remnant of the thyroglossal tract. The operative treatment must indeed always be drastic and must aim at the extirpation of the whole tract A high collar incision is made above rather than over the cyst. When the cyst has been dissected away from its bed it will be found that its upper end is attached by a strand of tissue to the body of the hyoid bone. The relation of the thyroglossal tract to the hyoid bone is variable, and it may pass in front of or through the bone instead of doubling in front of and then behind it as in Fig 876 The central part of the hyoid bone should, therefore be defined and its surfaces cleared with a rugine from muscular attachments. The bone is then cut through on either side with bone-forceps so that a section of the central part is removed and the thyroglossal tract followed upwards above the hyoid through the muscles at the base of the tongue. When the surface of the tongue at the foramen cæcum is reached the tract is clamped and tied without making an opening into the mouth The anæsthetist can help in defining the situation of the foramen cæcum by inserting his finger in the mouth. In this way the whole tract can be removed in one piece.

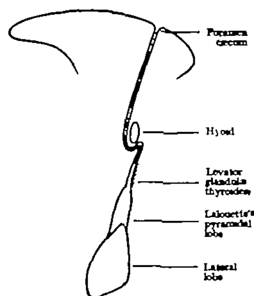


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The overlying muscles are split and the cavity containing the pus is entered by blunt dissection with the point of an artery or sinus forceps (Hilton s method) The cavity should be drained for as long as may be necessary to ensure that pus shall not re-accumulate Recovery is usually complete without interference with function.

A more chronic form of infection may occur in the degenerating contents of a long-standing cyst or adenoma of the thyroid Initial drainage may be needed for evacuation of pus and to relieve pain and pressure but this will not effect a permanent cure If the wound is allowed to heal and nothing further is done the process is likely to recur and it is therefore usually advisable to resect the affected part of the gland as described below

Other conditions formerly thought to be inflammatory lesions, such as woody thyroiditis and lymphadenoid goitre are no longer regarded as belonging to this category and their treatment is described in a later section (*see* p 2088)

THYROIDECTOMY

The Standard Operation of Thyroidectomy

It will be convenient to describe at this point the operation of partial thyroidectomy since all operations on the gland have their main steps in common The modifications necessary for the various pathological conditions demanding surgery can then be described with reference to the general plan.

The anæsthetic.—Very many thyroidectomies have been performed in the past under local analgesia and there may still occasionally be justification for its use. A field block of the cervical nerves combined with a local infiltration of the skin over the thyroid gland makes it possible to do the operation without pain to the patient though it must always be an ordeal for him and puts an additional strain on the surgeon At the present time a general anæsthetic is greatly to be preferred. Induction with intravenous pentothal followed by gas and-oxygen is usually quite satisfactory Many surgeons prefer the anæsthetist to use some ether in addition and this is sometimes coupled with the routine introduction of an endotracheal tube. Others regard this as entirely unnecessary for the great majority of patients and indeed pernicious since both ether vapour and tube may be contributory causes of tracheitis and respiratory infections. If a wide air way is introduced there need not ordinarily be any cyanosis or congestion and the surgeon can operate in perfect comfort. If however there is any degree of tracheal obstruction by the pressure of a goitre or if compression of the trachea is likely to result from manipulation of the gland then it will obviously be wise to use an endotracheal tube. The precise method to be used for anæsthetizing the patient should in fact be a matter of adaptation to individual needs and not simply a uniform routine.

The position of the patient —Easy access to the thyroid gland depends very much on the position of the patient on the operating table The neck must be thrown forwards and the head extended though the extension of the head must not be overdone so as to avoid undue tightening of the pretracheal and sternomastoid muscles Control of the

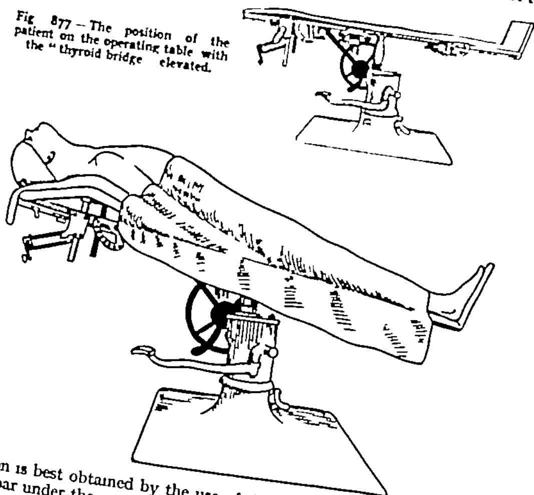


Fig 877 — The position of the patient on the operating table with the "thyroid bridge" elevated.

position is best obtained by the use of the "thyroid bridge" a transverse bar under the patient's shoulders which can be raised or lowered by means of a handle beneath the table and accessible to the anæsthetist (Fig 877) If this bridge is not available a firm wedge-shaped pillow can be used and this as it is pulled up or pushed down the table gives a very accurate control of the position A sand bag can be used but is less convenient

Infiltration of the skin —Infiltration of the subcutaneous tissues in the operation area is not essential but is useful in two ways The solution used should consist of normal salt solution with adrenaline hydrochloride added to make a strength of 1 part in 500 000 Adrenaline of this low concentration does not affect the pulse rate even of toxic patients but if it is given time to act will contract the superficial blood vessels well enough to save some time in obtaining hæmostasis

The raising of the skin and platysma muscle by the fluid also makes the dissection of the skin flaps easier The infiltration is made between the platysma and the deeper muscle layers. Nothing is gained by infiltrating between the pretracheal muscles and the thyroid gland

The incision.—The skin incision should be carried horizontally across the neck about an inch and a half above the clavicles (Fig 888) If it is placed too low access to the upper poles of the gland will be less easy to obtain It must also be remembered that the extension of the head has pulled up the skin normally covering the manubrium sterni on to the neck An incision into this part of

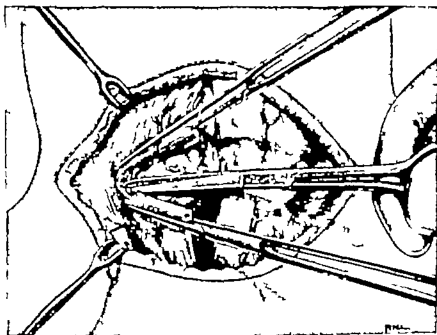


Fig 878.—Division of pretracheal muscles between clamps, the anterior jugular vein being already ligatured.

the skin may afterwards become adherent to underlying tissues and will also tend to become keloid. The length of the incision will be varied according to the size of the gland that is to be removed. An experienced operator will probably be content with a considerably shorter incision than will a less-experienced one Its length may vary from 3 to 5 in. according to circumstances The platysma muscle is divided with the skin and dissected up with it

Exposure of the thyroid gland.—When the flaps of skin and platysma muscle have been dissected upwards and downwards the surface is covered with small towels and the flaps are retracted by means of a self retaining retractor Joll s pattern is the most convenient. An incision is now made in the midline between the medial borders of the pretracheal muscles this being carried upwards over the larynx and downwards to the suprasternal notch. Care must be

exercised not to incise too deeply otherwise the surface of the gland will be cut and unnecessary bleeding will follow The pretracheal muscles are now lifted up from the surface of the left lobe (assuming that the operator is standing on the right of the patient) and a finger is introduced beneath them The size and disposition of the left half of the gland are thus determined The operator and his assistant then change places * and the same manœuvre is carried out on the right half of the gland A decision must be made as to whether the pre tracheal muscles shall be divided transversely or not This decision is likely again to be very much affected by the experience of the

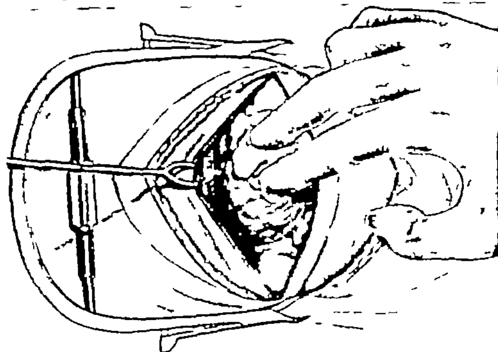


Fig 879 —Ligature of the right lateral thyroid vein.

operator Access is certainly made easier by the division of muscles but it is an absolute necessity only for the larger goitres and for those with size vascularity and fixity increased by prolonged preparation with thiouracil compounds Before the muscles are divided the anterior jugular veins should be underrun and tied above and below the line of division (Fig 878)

The connective tissue layers enveloping the right lobe of the gland are now peeled away with toothless dissecting forceps. An instrument with square ends is the most convenient for the purpose. Care is taken during this process not to tear through the middle thyroid vein or veins which may be of some size and leave the outer surface of the lobe about its middle. The veins are however variable they may unite to form one large channel ending in the internal jugular vein they may remain as two or more separate vessels or they may be

* It is, of course possible to do the operation without changing places, but in the writer's opinion the manipulation of each lobe from the opposite side as originally practised by Dunhill, has great advantages.

absent or so small as to be negligible. If the veins are large they sh be isolated and divided between artery forceps or it may be r convenient to pass a ligature round them with a carrier and tie t at their outer ends before clamping them on the surface of the gl Much bleeding and delay will be avoided by achieving this step precision (Fig 879)

Ligation of vessels.—The way is now clear for finding and liga the inferior thyroid artery Opinion has been divided on the neces

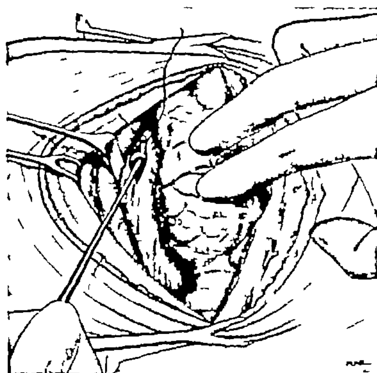


Fig. 880.—The right inferior thyroid artery exposed with ligature carrier passed beneath it.

for doing this many competent surgeons preferring to tie the branc as they enter the gland. One of the supposed objections is the lik hood of causing atrophy of the parathyroid bodies with consequ tetany Experience has not given substance to this idea rout ligature of both inferior thyroid arteries has not resulted in increase of the incidence of hypo-parathyroidism An important g from tying the arteries is the better hæmostasis that is obtained in parts of the gland that are left behind. The artery is exposed possible close to the point where it emerges from under cover *the common carotid artery To do this the loose* connective tis on the outer side of the thyroid lobe is separated by blunt dissect until the carotid artery is seen The assistant then places his retrac more deeply so that it retracts the artery as well as the musc

outwards The connective tissue is then separated still more deeply by opening the blades of curved scissors in a line parallel to and close beside the artery Usually the inferior thyroid artery comes into view lying on the longus cervicis muscle A thread ligature is passed round it with a carrier and the artery is tied in continuity (Fig 880) Thread is used because it is not absorbed so that the artery will not become

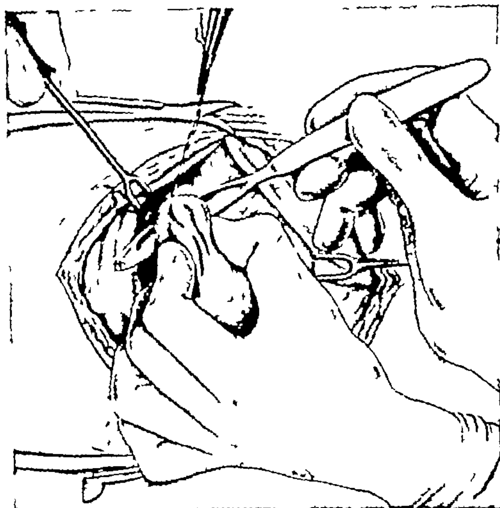


Fig. 881 —The upper pole of the right thyroid lobe isolated and elevated by a blunt dissector The vessels have been encircled and ligatured.

recanalized at a later date This is of importance in operating on thyrotoxic patients as it may discourage regeneration of the gland and consequent relapse Tying the artery in this way alongside the carotid will avoid any likelihood of injury to the recurrent laryngeal nerve the ligature being some distance external to its course There is thus no necessity for deliberate exposure of the nerve which is a time-consuming and undesirable manœuvre Ligature of the inferior thyroid artery would be quickly accomplished if it were constant in its position but unfortunately it is variable and is sometimes very difficult to find and may even be absent It may ascend obliquely to the gland coming from behind the cover of the carotid at a level below the operation area

or it may go upwards to an unusually high level before turning downwards and inwards towards the gland. In either event it will not be found in the expected position and it will usually be inadvisable to spend much time in searching for it since its branches can be caught and ligatured at a later stage.

Attention is next turned to the superior thyroid artery Sometimes the anterior branch of this is very large and conspicuous as it descends along the mesial border of the upper pole of the gland. Greater freedom of the upper pole may sometimes be obtained if this branch is divided and tied before mobilization is attempted. The upper part of the gland is now separated from the side of the larynx and the outer surface is peeled free of connective tissue right to the posterior border which may be curling round behind the larynx and pharynx. Separation is completed by passing a blunt dissector on the medial side behind the pole and out on the other side. The upper pole is pulled down with the fingers of the left hand and a thread is passed round the vascular pedicle with a carrier above the dissector The pedicle containing the superior artery and vein is then securely tied tension on it being relaxed while the knot is being secured. (Fig 881) Two narrow bladed artery forceps are then placed on the upper pole of the gland just below the ligature, and the gland is divided between them with a knife. A second ligature can now be tied on the pedicle to ensure that the first one shall not slip

The inferior thyroid veins should now be exposed by blunt dissection clamped and ligatured, so that both upper and lower ends of the lobe of the gland are mobilized.

The thyroidectomy—It then remains to remove as much of the lobe as is suitable in the circumstances. If a total thyroidectomy* is to be done a set of mosquito artery forceps should be available. These can be used to seize accurately each branch of the inferior thyroid artery as it enters the surface of the gland and also to preserve at any rate the inferior parathyroid body which can usually be identified by its shape and brownish colour lying on the posterior border of the *thyroid near its lower pole in close relation to a branch of* the artery More often the removal aimed at will be partial or subtotal and ordinary pressure forceps can be applied to the outer surface of the gland so as to preserve a strip or nodule of tissue from the posterior border This section having been accomplished along the outer surface the isthmus is then separated from the front of the trachea and the inner surface of the lobe is similarly clamped and cut, so that ultimately the front half of the circumference of the trachea will be left bare. The resected part of the lobe with the isthmus is then turned over to the other side and hæmostasis is effected in the strip that has been left. If the inferior artery has been tied in continuity the risk of reactionary hæmorrhage from the strip is small but the vessels must nevertheless

* This has been used for the treatment of failing heart, and it may be necessary in dealing with thyroid carcinoma (see p. 2090)

be dealt with carefully as there is still a blood supply coming from other sources such as the vessels of the larynx and œsophagus and the ascending pharyngeal artery Greater security is obtained by underrunning most of the vessels with catgut on a needle

The operator and his assistant again change places for the completion of the operation If the pyramidal lobe is present it must be detached

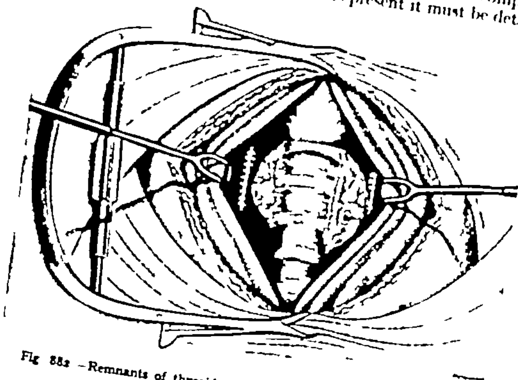


Fig 882 —Remnants of thyroid lobes left after subtotal thyroidectomy

from the larynx and the vessels accompanying it ligatured Complete removal of this lobe which sometimes extends as high as the hyoid bone must be achieved since any remnant left behind may afterwards hypertrophy and form an unsightly lump in a conspicuous place The steps of the operation carried out on the right lobe are now repeated on the left except that rather more of the glandular tissue is preserved The resection is easier to do as there is now greater mobility of the lobe and as more tissue is being left it may be possible to carry out a wedge-shaped resection and to suture the two edges together with a continuous stitch. In this way no raw surface is left and hæmostasis is very secure (Fig 882)

Drainage.—Strips of corrugated rubber are placed on either side of the trachea emerging through openings made in the muscles just in front of the anterior borders of the sternomastoids. Nothing is lost by routine drainage of the wound, and much blood stained serum is usually got rid of in the first 24 hours. Should post-operative hæmorrhage occur the presence of drainage strips will make it very quickly apparent —a great advantage in dealing with this dangerous complication

Closure of the wound.—If the pretracheal muscles have been divided transversely the cut edges are now sutured the approximation being assisted by lowering the thyroid bridge or pulling up the wedge pillow thus flexing the head a little The longitudinal incision between the muscles is next closed with a continuous suture and then the platysma muscle leaving openings at either end for the drainage

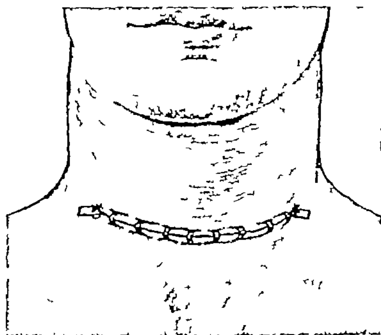


Fig 883 —Closure of wounds with skin-clips and rubber drains.

strips which are fixed to the skin with horsehair or fine nylon stitches. Finally the skin-edges are accurately approximated with horsehair stitches or clips (Fig 883)

The drainage strips are removed after 24 and the skin-clips after 48 hours

Linen thread is used by some surgeons throughout the operation for ligatures and sutures. This assumes that no operation wound is ever likely to become infected and there will, indeed be no trouble except in the rare event of wound infection One experience of this complication however is enough to condemn the use of thread for ever after except for ligaturing the main vessels to the gland. It is preferable to use plain catgut of the finest gauge that is compatible with safety It is particularly important to use the very finest material for ligature of the subcutaneous vessels and for suturing the platysma layer otherwise blebs of serum may develop at the site of each knot a week or more after the operation and these will tend to spoil the scar

Post-operative care and complications.—It is sometimes thought necessary to keep the patient sitting almost upright in bed for several days after the operation. There is however no reason for this and

the patient will be much more comfortable if sloped on several pillows with good support for the head Getting out of bed on to a commode may be allowed from the first in order to eliminate the use of a bed pan

Apart from post-operative reactions in toxic patients the only serious complication that is likely to occur is urgent hæmorrhage from a large vessel from which the ligature has slipped or come undone This happens occasionally even when the operative technique has appeared to be satisfactory The catastrophe is likely to have occurred at the pedicle of the superior thyroid artery through tying the ligature while the pedicle was under too great tension When this happens the patient is in danger of asphyxiation since the blood is flowing into the cavity of the wound faster than it can be carried off by the drainage strips and the pressure rises rapidly The incision must therefore be reopened *immediately* if necessary while the patient is in bed so that blood clot may be turned out the wound being temporarily packed with gauze The patient can then be taken to the operating theatre so that the bleeding vessel may be found and tied under suitable conditions

Ordinarily post-operative treatment will consist only of sedation with morphia or heroin during the first 24 hours and with milder remedies thereafter An aspirin phenacetin-caffein mixture in suspension in mucilage to be taken at frequent intervals is comforting to the patient and relieves the pain on swallowing which may be severe for the first two days. Some serum may collect beneath the skin several days after healing has taken place. This can be evacuated by making a small opening in the line of the incision with a probe or by aspiration with a syringe.

Convalescence is usually rapid and the patient may be allowed to get out of bed after a week or less according to circumstances

If one or other inferior laryngeal nerve has been injured the alteration in the patient s voice will be noticed immediately after return of consciousness and there will be a tendency to choke when swallowing fluids. If vocal cord paralysis is suspected laryngoscopy will immediately settle the matter and if one cord is in the cadaveric position the paralysis is likely to be due to division of the nerve and will be permanent The voice will nevertheless gradually recover as the other cord compensates by moving over to the affected side If the loss of movement of the cord is only partial it is probably due to manipulation of the nerve during the operation and complete recovery of the voice will take place within a few weeks Sometimes the voice is normal for some days after operation and then begins to give signs of vocal cord weakness This is likely to be due to infiltration of blood around the nerve and within its sheath and recovery will quickly follow Injury to the superior laryngeal nerve producing weakness of a crico-thyroid muscle may affect the voice in a minor degree but it will be transient Bilateral vocal cord paralysis has been known to occur and is a surgical disaster of the first order which may necessitate an emergency tracheotomy The treatment of this condition is in the

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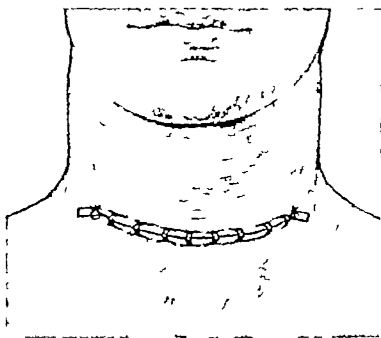


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Ordinarily post-operative treatment will consist only of sedation with morphia or heroin during the first 24 hours and with milder remedies thereafter An aspirin-phenacetin-caffein mixture in suspension in mucilage to be taken at frequent intervals is comforting to the patient and relieves the pain on swallowing which may be severe for the first two days. Some serum may collect beneath the skin several days after healing has taken place This can be evacuated by making a small opening in the line of the incision with a probe or by aspiration with a syringe.

Convalescence is usually rapid and the patient may be allowed to get out of bed after a week or less according to circumstances.

If one or other inferior laryngeal nerve has been injured the alteration in the patient s voice will be noticed immediately after return of consciousness and there will be a tendency to choke when swallowing fluids. If vocal cord paralysis is suspected laryngoscopy will immediately settle the matter and if one cord is in the cadaveric position the paralysis is likely to be due to division of the nerve and will be permanent. The voice will nevertheless gradually recover as the other cord compensates by moving over to the affected side If the loss of movement of the cord is only partial it is probably due to manipulation of the nerve during the operation and complete recovery of the voice will take place within a few weeks. Sometimes the voice is normal for some days after operation and then begins to give signs of vocal cord weakness This is likely to be due to infiltration of blood around the nerve and within its sheath and recovery will quickly follow Injury to the superior laryngeal nerve producing weakness of a crico-thyroid muscle may affect the voice in a minor degree but it will be transient Bilateral vocal cord paralysis has been known to occur and is a surgical disaster of the first order which may necessitate an emergency tracheotomy The treatment of this condition is in the

sphere of the laryngologist who may be able to relieve it effectively by fixation of the arytenoids Section of the recurrent laryngeal nerve has been repaired by open operation but the technique is very difficult and success improbable

Post-operative tetany due to hypo-parathyroidism is seldom seen, but when it occurs may be difficult to treat. Fortunately it is usually transient and while it lasts will respond to massive doses of calcium gluconate (200 to 300 grains four hourly) by the mouth Sometimes it becomes evident only at the menstrual periods. Parathyroid grafting is useless and the deficiency can only be treated medically

By the exercise of constant care and reasonable skill the operative mortality following thyroidectomy for whatever cause should be in the neighbourhood of zero

ADENOMA OF THE THYROID

Single adenomata of the thyroid merit removal whenever they are detected. They always get larger often become toxic and are the source of the majority of the malignant growths occurring in the thyroid. They may occur in either lobe or in the isthmus and can usually be removed without disturbing the unaffected parts of the gland. The exposure of the tumour is effected in the manner already described. Only if the tumour is very large need the incision be carried further out on the affected than on the normal side Formerly enucleation of an adenoma used to be practised A partial thyroidectomy is now favoured that is to say the portion of the gland containing the adenoma is removed since this avoids the bleeding which is inseparable from enucleation of the tumour from its bed. Sometimes the necessary removal amounts to a hemithyroidectomy as when the tumour occupies almost the whole of the lobe. In these circumstances the recurrent laryngeal nerve is in considerable danger as it is liable to be displaced by the tumour and special care must be exercised in stripping the posterior surface and in placing the artery forceps on the vessels as they pierce the capsule. *(See Fig 878)* Ligature of the main vessels to the lobe is done as in the standard operation.

If the adenoma is arising in the isthmus then both lateral lobes may be left undisturbed but the front of the trachea should be left bare.

The danger of hæmorrhage into a cystic adenoma giving rise to compression of the trachea is often given as a reason for removal of these tumours. In fact this event is a very uncommon one though an emergency operation may occasionally be demanded. Removal is then the proper course rather than a tracheotomy since the obstruction will be completely relieved as soon as the mass is delivered from the wound.

COLLOID GOITRE

A colloid goitre being a diffuse enlargement of the gland may be more or less symmetrical but may nevertheless cause obstruction

by side-to-side narrowing of the trachea. Colloid goitre commonly occurs in quite young people whose tracheas are soft and an endotracheal tube is advisable in operating on such patients. This will not only deal with the obstruction from outside pressure but will also anticipate collapse of the trachea after the constricting but also supporting gland has been removed. This collapse may occur after the operation is completed, during the deep breathing of recovery from the anæsthetic. For this reason the endotracheal tube should not be removed until the patient is almost or quite conscious.

A long incision will be needed for removal of a large colloid goitre and division of the pretracheal muscles may also be demanded The steps of the operation are as described above except that the resection should be more conservative than in most other types of goitre The tissue does not have a physiological activity proportional to its size and the patient is likely to be young A considerable amount of the posterior part of each lobe should be preserved, and it may be argued that the inferior vessels should not be tied owing to the danger of producing ischæmia of the remaining tissue with consequent myxœdema. It should usually be possible to remove a wedge of tissue from each side in such a way that the capsule can be sutured over the cut surfaces. The pyramidal lobe may be very large in a colloid goitre and care should be taken to remove the whole of it

NODULAR GOITRE

It may not be easy to distinguish a nodular from a colloid goitre since one develops slowly from the other Usually however the irregularity of the nodular goitre has suggested the diagnosis The same observations concerning the use of an endotracheal tube and conservation of tissue are applicable to this condition though in dealing with a nodular goitre the decision as to how much tissue to leave behind may be difficult All the tissue will appear to be grossly pathological and the contents of each individual nodule will tend to disintegrate when it is cut into The operator need not however be seriously worried about the danger of leaving too little. So often the patient is elderly and does not need much thyroid tissue particularly if the goitre was becoming toxic as it so commonly does In addition the balance is easily restored by oral administration of thyroxin if signs of deficiency appear

Nodular goitres may present an important complication by the presence of intra thoracic extensions into either the anterior or the posterior mediastinum Frequently these have made themselves felt by increasing respiratory obstruction and venous congestion in the neck and their position may be determined by radiography Nodules may extend well below the level of the arch of the aorta in the anterior mediastinum. Nevertheless these extensions can nearly always be removed from above without great difficulty If the lower limit cannot be reached with a finger then the affected lobe

is first isolated in the neck until its only remaining attachment is with the intra thoracic portions of the gland Gentle traction on the lobe will then deliver the extensions without difficulty Evisceration of an intra thoracic goitre is messy and may lead to overlooking further nodules which have only strands of connective tissue connecting one with another Evacuation of fluid from a cystic nodule with a syringe will diminish its size and so assist its removal.

In exceptional circumstances it may be necessary to open the anterior mediastinum by splitting the sternum in the same way as for thymectomy (*q v*) or for removal of a mediastinal parathyroid tumour Transpleural operations should be reserved for aberrant intra thoracic thyroid tumours which have lost all connection with the gland in the neck and may even lie upon the diaphragm.

TOXIC GOITRE

The surgery of toxic goitre is a very large subject if treated exhaustively the ætiology of the disease its varieties complications and therapeutics forming a complicated background to the surgical technique. Operative surgery must take account of this since the safety of the operation depends so largely on the operator s knowledge of the whole subject. In the present context however condensation is essential and most of the technique has already been described in the foregoing sections.

The convenient clinical distinction between primary and secondary toxic goitre will simplify any description of surgical details.

Operation for secondary toxic goitre.—The operative details will be the same as for single adenoma and nodular goitre except that for toxic nodular goitres the resection will be more drastic than for the non toxic forms It used to be doubted whether a true toxic adenoma forming in a non toxic gland could occur However investigation with radio-active isotopes of iodine has shown that a solitary adenoma can be toxic without the other parts of the thyroid being affected so that the operation of resection for this should be done exactly as described and will be perfectly effective.

A colloid goitre may become toxic even in quite young people, and it is important to do a fairly drastic removal in all patients. More of the gland should be left however than in dealing with a primary thyrotoxicosis as it is much less active in proportion to its size. No rule can be laid down only the experience of the operator and knowledge of the individual patient can serve as guides It will be advisable to tie the inferior thyroid arteries not only as a step in the operation of removal but also in order to discourage active regeneration

A secondary toxic goitre of the nodular variety is usually found in the middle aged and old. The tissue of the gland will be much more degenerate than in a colloid goitre and some of the patients will be suffering from auricular fibrillation, or even congestive heart failure. Resection should therefore be much more drastic and in old people

with auricular fibrillation or heart failure it may be virtually total though with due regard for the survival of at least two of the parathyroid bodies. It is found that such patients seldom develop any signs of myxœdema. Should they do so the condition may be remedied by administration of synthetic thyroxin by the mouth

The general details of the operation including those for intrathoracic extensions will be the same as for non toxic nodular goitre

Primary toxic goitre (exophthalmic goitre, Graves' disease) — In this disease the thyroid gland is usually diffusely and symmetrically enlarged so that the standard operation as described above is applicable There is however great variation in the state of the gland chiefly as regards its vascularity consistency and friability so that what may promise to be a routine affair may prove in the end to be exceedingly difficult. Apart from these natural variations a large proportion of such patients will nowadays have been treated for a longer or a shorter time with a thiouracil compound, and there can be no doubt that these drugs have tended to make the technique of thyroidectomy more difficult, even though they have made the operation safer It is now well known that thiouracil treatment may make the gland much larger and harder in consistency The vascularity of the gland will also be enormously increased and it is recognized that no patient should ever be operated on while under the influence of a thiouracil compound only If this is attempted, the hæmorrhage from the surface of the gland may be torrential and uncontrollable seriously endangering the life of the patient This may be avoided if the patient is given an adequate amount of iodine by mouth for two or three weeks after the administration of the thiouracil has been stopped (usually in the form of Lugol s solution m iii or v t d.s.) Nevertheless even after taking this precaution the gland may still be abnormally vascular unduly adherent to its surroundings and of a consistency which although hard to the touch, may make the grip of an artery forceps unreliable.

It is in fact necessary to state emphatically that the routine preparation with thiouracil of all patients with primary toxic goitre is surgically undesirable For the milder degrees of the disease it is quite unnecessary all the response that is needed being obtained by preparation for three or four weeks with Lugol s solution phenobarbitone and rest Thiouracil may be used for the preparation of those patients who are more seriously ill provided that it be not assumed that the operation will be a simple and straightforward affair The thyroid surgeon should never approach any operation in too light hearted a frame of mind and, above all, not in those patients who have had thiouracil

There is the additional complication that some patients who have had thiouracil in too great a quantity or for too long will be already in a state of myxœdema whatever the size of the gland. In patients who have not had thiouracil the ligature of the inferior thyroid vessels should be done even at the cost of some loss of time since relapse is usually due to regeneration of the toxic gland. Whether the

vessels should be tied in a patient suffering from a drug induced myxœdema is debatable. Ordinarily too the resection of the primary toxic gland should be drastic—subtotal as it is called In the myxœdematous patient it should probably be more conservative.

In the general description of the operation mention was made of the necessity for removal of the whole of the pyramidal lobe. This is particularly necessary in the patient with a primary toxic goitre as a pyramidal remnant may afterwards undergo hypertrophy large enough to cause a relapse. It may also make a very unsightly lump in a conspicuous place.

Modern methods of preparing toxic patients for operation with thiouracil compounds and iodine or with iodine alone have virtually eliminated the severe post-operative reaction and thyroid crises' which used sometimes to be seen Toxic patients tend to lose much water by perspiration and the loss must be made good with extra fluid given by the mouth, or sometimes by a rectal drip during the first few hours after operation. Otherwise there is no specific treatment for toxic patients. It is generally agreed that administration of iodine after operation serves no useful purpose Convalescence will naturally not be as rapid in toxic, as in non-toxic patients Ten days in bed may be advisable and thereafter a lazy life and absence of responsibilities should be enjoined for several weeks if domestic circumstances allow There is often an increase of weight amounting to as much as a stone during the first six weeks after operation but this is not necessarily an indication of surgical myxœdema as the patient sometimes seems to suppose The return to normal weight is often so rapid as to be somewhat alarming

LYMPHADENOID GOITRE (HASHIMOTO S DISEASE) RIEDEL'S DISEASE (WOODY THYROIDITIS)

These conditions of obscure ætiology were formerly regarded as inflammatory conditions of the gland. Pathological opinion is still very reticent in its pronouncements though it seems clear that the lymphocytic infiltration of the gland with fibrosis of varying degree and disintegration of the thyroid vesicles is a progressive change which may end in myxœdema. The changes are not *infrequently* accompanied in the earlier stages by some degree of thyrotoxicosis and there may be an obscure relation between these conditions and primary toxic goitre It has been held that lymphadenoid goitre and Riedel s disease are quite distinct conditions though there are reasons for thinking that the distinction may be artificial the conditions known by these names being really variations of the same process. From the viewpoint of operative surgery the distinction may be convenient since the two extremes lymphadenoid goitre and Riedel s thyroid, present such very different features The lymphadenoid gland may be hard in consistency and large but it is usually mobile and does not tend to cause serious obstruction of the trachea. The whole gland is

affected, but still contains some functioning thyroid tissue throughout so that a fairly drastic removal may be done without the risk of precipitating myxœdema. The partial thyroidectomy should be done as described under the standard operation with due regard to the age of the patient and the relative need for thyroid tissue Infiltration of the gland with lymphocytes being so marked a feature of the histology of the lymphadenoid goitre there can be no doubt that deep X ray therapy will be very effective in reducing the size of the gland and relieving pressure Since however the diagnosis can only be made with certainty by obtaining a specimen for biopsy the operation for partial thyroidectomy will probably have been done before the diagnosis has been fully established

The other extreme Riedel s thyroid is characterized by great *hardness and fibrosis of the gland from which all thyroid tissue may* have disappeared. This process may be much more advanced on one side than on the other and so may give rise to a preliminary diagnosis of thyroid carcinoma, the two conditions being clinically almost in distinguishable Even when the affected lobe has been exposed the operator may still be in doubt and it will then be advisable to remove it as completely as possible. Even an immediate histological section may be difficult to interpret and so will be an unreliable guide. The operation will be difficult the gland being closely adherent to the overlying muscles and to the side of the larynx and trachea. It may be necessary to remove part of the muscles with the gland which must, however be patiently separated from the other structures related to it. When the whole gland is affected by this dense fibrosis the diagnosis will be more evident and the main object of the operation will be to release the trachea from the thyroid which grips it as in a vice and is likely to cause some degree of respiratory obstruction. Removal of the isthmus and the anterior half of each lobe will effect the necessary release of the trachea and it will be better to leave the posterior part on either side. Insistence on the removal of the entire gland from its indurated and adherent surroundings will endanger the integrity of the recurrent laryngeal nerves and so may have serious consequences for the patient.

Occasionally this advanced fibrosis in an enlarged thyroid gland may result in a sudden and urgent dyspnœa, demanding an emergency tracheotomy Such an operation may be extremely difficult and may necessitate the removal of a quantity of almost cartilaginous material before the trachea can be found The tissues will not, however be very vascular and boldness in their removal will be rewarded by saving the patient s life

CARCINOMA OF THE THYROID

Thyroid carcinomas present themselves in a variety of forms and no rules can be laid down for their surgical treatment. There are however certain general principles which will serve as a guide to the

surgeon who will have to adapt his treatment to the circumstances of the individual patient

Firstly it must be remembered that malignant disease of the thyroid is on the whole late in forming metastases so that the situation should seldom be regarded on that account as hopeless Secondly the growths whether primary or secondary are very often sensitive to deep X ray therapy though it is always advisable to make the task of the radio-therapist as light as possible by removing as much of the diseased tissue as can reasonably be done It follows therefore that most patients with thyroid carcinoma should be submitted to operation for surgical extirpation of the disease as far as is rational and safe and that all of them should receive expert deep X ray therapy as soon as possible afterwards It is better to perform an incomplete removal of the growth and to rely on X ray treatment to deal with what remains than to do a heroic extirpation with a partial or complete laryngectomy or ligature of the common carotid artery

Following these principles the operative treatment of thyroid carcinoma will consist of one of the operations already described with modifications suggested by the operator's common sense. Thus a malignant adenoma may not have transgressed the capsule of the tumour so that the operation may scarcely differ from excision of an ordinary adenoma. On the other hand a massive and rapidly proliferating growth may be found to have extensions around the larynx and trachea or into the mediastinum and so may be inaccessible or obviously dangerous to remove The growth should then be cut through and the accessible portion removed together with the overlying muscles the remaining part being exposed to X rays as soon as the wound is healed A tracheotomy should be done at the same time when the disease is advanced. This may become an urgent necessity afterwards and will then be very difficult. Again a small growth may encourage the operator to attempt the removal of the whole of the affected lobe and indeed a careful and deliberate dissection in the manner described above may sometimes almost effect this If however a small part of the growth has to be left where it has begun to infiltrate in the angle between the larynx and pharyngo-œsophagus the surgeon need not be unduly perturbed since such a residuum may disappear completely under irradiation.

The recent introduction of radio-active isotopes of iodine has not yet materially influenced the surgery of thyroid carcinoma, since very few of the tumours are capable of fixing the iodine ions and so remain unaffected by the treatment. Surgical extirpation remains the first line of defence and should always be done if possible.

There is one other aspect of thyroid carcinoma which deserves consideration and that is the set operation of total extirpation of the gland. This may be done for two reasons. Firstly there may be metastases in different parts of the body without clinical evidence of a primary growth in the gland itself The metastases may take the form of the so-called lateral aberrant thyroid to which reference has

already been made (p 2073) or there may be a skeletal deposit leading to pathological fracture of a long bone or pelvis In either event a total extirpation of the gland according to the standard operation may reveal a small primary growth although serial sections may be needed to find it. Secondly it is believed that if a thyroid metastases will not take up radio-active iodine isotopes it may sometimes be found to do so when all the thyroid tissue possessing a greater avidity for iodine has been removed. There is then a chance that the metastatic growth may regress so that a meticulous thyroidectomy as described above will have been justified

THYROID GRAFTS

The treatment of myxœdema whether congenital or acquired by heterogenous thyroid grafts has been tried in the past, thyroid tissue being introduced into positions such as the sheath of the rectus abdominis the neck or the medulla of the tibia, but the grafts have not survived for long and it is generally agreed that the procedure is usually futile. If the attempt is made the neck is the most favourable site for the graft being its natural habitation.

It is, therefore not now necessary to describe the operations that have been devised. Thyroid deficiency can be treated much more accurately and effectively by giving synthetic thyroxin by the mouth

THE PARATHYROID GLANDS

Anatomy —The normal parathyroid glands have already been mentioned (p 2069) but there is much variation in both their number and position Tetany due to removal of the parathyroid tissue is so seldom seen after operations on the thyroid gland that it seems that variation in the direction of increase in the number is more common than decrease It is probable that there may be as many as seven or eight. The range in the position of the parathyroid bodies extends from the upper pole of the thyroid gland to the pericardium

It is presumably the lower parathyroid body that may descend into the thorax since it develops in association with the thymus gland from the third branchial complex and will descend with it. There is also a tendency for the upper parathyroid to move downwards and backwards so coming to lie behind the carotid artery almost in the superior mediastinum The importance of these variations lies firstly in the fact that when the parathyroids are in outlying positions they will obviously be in no risk of removal even with the most drastic thyroidectomies and secondly that parathyroid tumours may be found in any of the positions that may be reached by the normal glands

Physiology —The physiological function of the parathyroids is the endocrine control of the calcium metabolism of the body Over activity results in a greatly increased demand for calcium in the circulation and a corresponding increase in the amount excreted by the

kidneys. This demand usually cannot be supplied by the food and calcium is consequently removed by increased osteoclastic activity in the skeleton which undergoes progressive rarefaction and weakening rendering the bones liable to fracture on slight provocation or even spontaneously

Operations on the Parathyroid Glands

Hyper parathyroidism is the only condition calling for surgical operations on the glands and this state may be due either to hyper plasia of parathyroids or to the presence of a parathyroid adenoma. The abnormal calcium and phosphorus metabolism that results gives rise to a great variety of clinical signs and symptoms usually cul minating in the pathological fracture of a bone owing to *osteitis fibrosa cystica* or in the formation of renal calculi or both Sometimes multiple renal calculi are present without there being any abnormality of the bones and renal function may be seriously impaired. The diagnosis of hyper parathyroidism cannot be definitely made and no operation should be done unless there is a marked rise in the serum calcium and a corresponding fall in the plasma phosphorus. The calcium balance may give confirmation. Typical figures are as follows —

	Normal	*Abnormal*
Serum calcium	10 mg	16 mg per 100 c.c.
Plasma phosphorus	8 mg	0 8 mg per 100 c.c.

Hyperplastic parathyroid glands can never and adenomas can very seldom be palpated on examination of the neck or demonstrated by X rays There is usually no clue therefore to guide the operator in making his search and the exposure of the thyroid gland will be done as for the early stages of the standard operation (p 2074) in order to confirm the diagnosis. When the thyroid has been defined and the lateral thyroid veins if present have been ligatured and divided, each lobe in turn is mobilized and gently drawn forwards the arteries need not be divided. The parathyroid bodies can be easily identified, and it may be that an adenoma of one or other will be found. The tumour may be cystic or may be solid and of the same brownish colour as the normal gland. Its vessels are clamped and divided and it is removed. Not infrequently however as already mentioned the tumour may be in an abnormal position and is not discovered by the ordinary exposure. Search is first made above the upper pole of each thyroid lobe then behind the œsophagus, and then at the thoracic inlet both in front of and behind the common carotid artery and on both sides. If careful search of the whole area proves fruitless mediastinotomy will have to be considered. If no definite pathology is disclosed, but the para thyroid bodies appear obviously larger than normal two may be removed the operator having satisfied himself that one or two others still remain The wound may then be closed in the ordinary way and the effect on the calcium level in the serum noted. If no parathyroid

hyperplasia can be detected then the mediastinotomy may be undertaken forthwith or if the serum and phosphorus level remains as before after removal of supposedly hyperplastic glands the operation can be done on another occasion. The mediastinum is opened as in the standard operation (p 2096) and the parathyroid tumour is sought for by exposing the whole of the thymus gland The tumour may be associated with any part of the thymus as far down as the pericardium and occasionally it has been found lying behind the thymus or embedded in its substance. Thus removal of the thymus may have to be done and there is no objection to this since there are no side effects to be considered When the parathyroid tumour has been found and removed the mediastinum is closed as described (p 2099)

Results.—When a parathyroid tumour has been removed, the patient s serum calcium level will usually fall to below normal within 24 hours and there may be signs of incipient tetany These will be controlled by giving very large doses of calcium gluconate (200 to 300 grains four hourly) by the mouth and within a few days the serum calcium will return to normal. The bones will recalcify in the course of time though it may take many months or even a year or two before their radiographic appearance becomes approximately normal and the acquired deformities will remain If the disease was of long standing before the operation was done surgery is likely to prove palliative only the patient succumbing to renal insufficiency before many years have passed.

THE THYMUS GLAND

Anatomy and physiology—The thymus gland consisting of two more or less symmetrical lobes extends from the isthmus of the thyroid gland to the pericardium lying therefore, for the most part in the mediastinum behind the sternum Each lobe is of elongated form with a narrow cornu above where it meets the isthmus of the thyroid, and a wider thicker body which spreads out below into a thin sheet The two cornua lie at the root of the neck beneath the pretracheal muscles being in the same plane as the thyroid gland. The rest of the gland lies behind the manubrium and body of the sternum, but is separated from the manubrium by muscle attachments and connective tissue and lower down is covered by a variable degree of overlap from either side of the lungs and pleuras. The gland is entirely covered by pleura below the level at which the two membranes meet in the midline

Posteriorly the thymus gland lies on the inferior thyroid veins and trachea above and below this on the left innominate vein the aorta, and the pericardium The lobes are moulded to some extent over the curve of the aorta, and so when they are large may lie in a lateral relation to this vessel. Occasionally one or both lobes of the thymus may lie behind the left innominate vein instead of in front of it. (*See* Fig 888)

A small blood vessel is related to each cornu of the thymus gland. Two or more vessels also enter its lateral borders obliquely coming from the thyrocervical trunks or from the internal mammary arteries. The venous drainage gathers into a *vein on the posterior surface* of each lobe. These veins may empty separately into the left innominate vein but more often they unite to form a single large vein (undescribed by anatomists) draining into its anterior aspect

The thymus gland is a conglomeration of small lobules consisting chiefly *of lymphoid cells* these are congregated more densely at the edges of the lobules than in the centre so differentiating the lobule into cortex and medulla. There is also a framework of large reticular cells of epithelial (entodermal) origin and the more obviously epithelial Hassall's corpuscles (ectodermal) are scattered irregularly through the gland.

The thymus is very large in the fœtus and infant but becomes relatively smaller as age advances. It weighs on an average 15 to 20 grm in young adults and may sometimes exceed 30 grm. but tends to become lighter and more fatty in older people. The normal gland has no known function Abnormally it appears to produce an endocrine secretion which is responsible for the condition known as myasthenia gravis probably by interfering with the production or action of acetylcholine.

Operations on the Thymus Gland

Indications.—Most operations that are done at the present time on the thymus gland are for the relief of myasthenia gravis, and the gland may or may not be the seat of a tumour Rarely a thymic tumour may grow without causing any symptoms other than those due to pressure on surrounding structures when it becomes very large In the localized or general weakness of the voluntary muscles produced by the abnormal secretion the distribution of the signs is very variable *Myasthenia gravis is distinguished from all other forms* of muscular weakness by its quick response to the drug neostigmine (Prostigmine) given by injection or by the mouth This drug appears to reinforce the action of acetylcholine perhaps by antagonizing the cholinesterase in the body but its effect is transient the patient having to take successive doses at a few hours interval. A thymic *tumour* is present in 12 to 15 per cent of all patients with myasthenia gravis and there is then often a more rapid onset and, on the whole more pronounced symptoms and a slower and less complete response to the drug than when there is no tumour The presence of a tumour greatly increases the surgical risks since apart from the probable severity of the disease when due to a tumour its removal may necessitate opening one or both pleural cavities and their complete closure afterwards may be difficult or impossible A patient with generalized myasthenia gravis is likely to be suffering from some impairment of the respiratory mechanism owing to weakness of the intercostal muscles or of the

diaphragm or both with a corresponding liability to contract pulmonary infections With any infection the myasthenia becomes worse so that a vicious circle is established Even a temporary and partial collapse of a lung is therefore to be avoided if possible should a collapse be unavoidable measures to ensure rapid re-expansion of the lung may have to be taken —usually by aspiration of air from the pleural cavity particularly if there is blood or serum in the pleural cavity When there is no fluid and the patient is comfortable the lung may be allowed to expand naturally

In general, it has been found that the result of primary removal of thymic tumours for myasthenia gravis has given very unsatisfactory results partly owing to the higher mortality—partly owing to the frequency of severe and irreversible relapse of the disease even after an initial recovery It is better to diagnose the presence of thymic tumours by radiography and tomography and to treat them in the first place by accurate deep X ray therapy Their removal may then be attempted when the symptoms have improved and the reaction has subsided. Operation therefore has to be postponed for about four months after the diagnosis has been made.

Primary thymectomy is thus reserved for those patients who have a persistent thymus without any tumour formation

Preparation of the patient.—The slightest degree of respiratory infection is an absolute contra indication to operation until it has been overcome. Meanwhile the dosage of neostigmin with or without ephedrine must be taken to the highest level that the patient will tolerate to enable him to reach a scale of activity as nearly normal as possible. The dose is commonly over 200 mg in 24 hours and may rise to 800 or even 1 000 mg Common sense and experience will withhold operation when the patient is so ill that any interference would obviously be fatal. Apart from this there is no specific preparation Constipation should be corrected by laxatives or aperients since it is dangerous to give a myasthenic patient an enema which will probably produce an immediate and alarming syncope.

The anæsthetic.—After premedication with omnopon and scopolamine induction is effected by intravenous pentothal and this is followed by a fully controlled anæsthesia with cyclopropane or gas and oxygen No endotracheal tube is necessary its use may cause some minor degree of tracheal irritation and subsequent coughing which will give the patient avoidable fatigue It is usually possible to maintain a good respiratory exchange with the minimum of pleural movement—an important consideration during the operation of thymectomy

Position of the patient—The upper part of the patient s chest should be thrown forward by the thyroid bridge or the wedge pillow and the head extended as for thyroidectomy

If the chest slopes forward as it often does in women it may be made level by tilting the table with the feet downwards.

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Operations on the Thymus Gland

Indications.—Most operations that are done at the present time on the thymus gland are for the relief of myasthenia gravis, and the gland may or may not be the seat of a tumour Rarely a thymic tumour may grow without causing any symptoms other than those due to pressure on surrounding structures when it becomes very large. In the localized or general weakness of the voluntary muscles produced by the abnormal secretion the distribution of the signs is very variable. Myasthenia gravis is distinguished from all other forms of muscular weakness by its quick response to the drug neostigmine (*Prostigmine*) given by injection or by the mouth This drug appears to reinforce the action of acetylcholine perhaps by antagonizing the cholinesterase in the body but its effect is transient the patient having to take successive doses at a few hours interval. A thymic tumour is present in 12 to 15 per cent. of all patients with myasthenia gravis and there is then often a more rapid onset and, on the whole more pronounced symptoms and a slower and less complete response to the drug than when there is no tumour The presence of a tumour greatly increases the surgical risks since, apart from the probable severity of the disease when due to a tumour its removal may necessitate opening one or both pleural cavities and their complete closure afterwards may be difficult or impossible A patient with generalized myasthenia gravis is likely to be suffering from some impairment of the respiratory mechanism owing to weakness of the intercostal muscles or of the

diaphragm or both with a corresponding liability to contract pulmonary infections. With any infection the myasthenia becomes worse so that a vicious circle is established Even a temporary and partial collapse of a lung is therefore to be avoided if possible should a collapse be unavoidable measures to ensure rapid re-expansion of the lung may have to be taken —usually by aspiration of air from the pleural cavity particularly if there is blood or serum in the pleural cavity When there is no fluid and the patient is comfortable the lung may be allowed to expand naturally

In general, it has been found that the result of primary removal of thymic tumours for myasthenia gravis has given very unsatisfactory results partly owing to the higher mortality—partly owing to the frequency of severe and irreversible relapse of the disease even after an initial recovery It is better to diagnose the presence of thymic tumours by radiography and tomography and to treat them in the first place by accurate deep X ray therapy Their removal may then be attempted when the symptoms have improved and the reaction has subsided. Operation therefore has to be postponed for about four months after the diagnosis has been made.

Primary thymectomy is thus reserved for those patients who have a persistent thymus without any tumour formation

Preparation of the patient.—The slightest degree of respiratory infection is an absolute contra indication to operation until it has been overcome. Meanwhile the dosage of neostigmin with or without ephedrine must be taken to the highest level that the patient will tolerate to enable him to reach a scale of activity as nearly normal as possible. The dose is commonly over 200 mg in 24 hours and may rise to 800 or even 1 000 mg Common sense and experience will withhold operation when the patient is so ill that any interference would obviously be fatal. Apart from this there is no specific preparation Constipation should be corrected by laxatives or aperients since it is dangerous to give a myasthenic patient an enema which will probably produce an immediate and alarming syncope

The anæsthetic.—After premedication with omnopon and scopolamine induction is effected by intravenous pentothal and this is followed by a fully controlled anæsthesia with cyclopropane or gas and oxygen No endotracheal tube is necessary its use may cause some minor degree of tracheal irritation and subsequent coughing which will give the patient avoidable fatigue It is usually possible to maintain a good respiratory exchange with the minimum of pleural movement—an important consideration during the operation of thymectomy

Position of the patient.—The upper part of the patient s chest should be thrown forward by the thyroid bridge or the wedge pillow and the head extended as for thyroidectomy

If the chest slopes forward as it often does in women it may be made level by tilting the table with the feet downwards.

The operation of thymectomy—Time and blood loss may be saved by a preliminary subcutaneous injection of the operation area with a dilute solution of adrenaline in normal saline. A T-shaped incision is then made as in Fig 884 the horizontal limb being a short distance above the suprasternal notch and the vertical limb extending down to the level of the fourth rib or lower according to circumstances If the thorax is short adequate access to the mediastinum can be obtained by splitting the sternum as far as the third or fourth intercostal space. If it is long the split must be taken down almost to the xiphisternum Unnecessary interference with the integrity of the thoracic cage should be avoided.

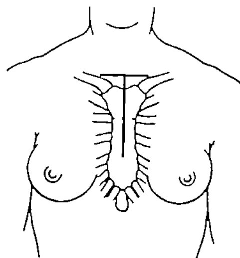


Fig. 884—The position of the skin incision for thymectomy

When the incision has been made through the skin and subcutaneous layers flaps should be dissected back for a short distance. The pretracheal muscles are then separated by blunt dissection with curved scissors above the suprasternal notch and a blood vessel which usually crosses the notch transversely is secured. The suprasternal ligament is divided down to the bone. The index finger of the left hand is then inserted behind the manubrium and muscular attachments to its under surface are separated as far as the finger will reach It was formerly the writer s practice to expose the second or third intercostal space and after pushing the pleura away on either side by inserting a curved blunt dissector to divide the sternum transversely into the space chosen by means of a sternum shears. This transverse cut was however difficult to fix afterwards during the closure of the thorax and was probably responsible for a good deal of the pain experienced by patients from the respiratory movements. An equally good exposure of the mediastinum can be obtained without making the transverse cut if the longitudinal division is taken if necessary as far as the xiphisternum. This is done with a Sauerbruch s sternum splitter (Fig 885) Care must be used to separate the pleura in the midline from the back of the sternum before the sternum splitter is introduced for each successive bite A transverse division of the bone may still be needed occasionally for removal of a tumour which has formed in a lateral position. The longitudinal division of the bone is made easier if the outer table is first cut through with a Hey s saw (A rotary saw can of course be used but its introduction is really an unnecessary complication in an operative detail which is so easily done without it.) When the sternum has been divided a strong self retaining retractor is inserted, and the two halves of the bone are forced apart until a gap

of about 3 in. gives access to the mediastinum If there is much bleeding from the cancellous bone of the sternum it can be controlled with Horsley s wax (Fig 886) The connective tissue is divided in the midline with scissors and the capsule of the underlying thymus gland

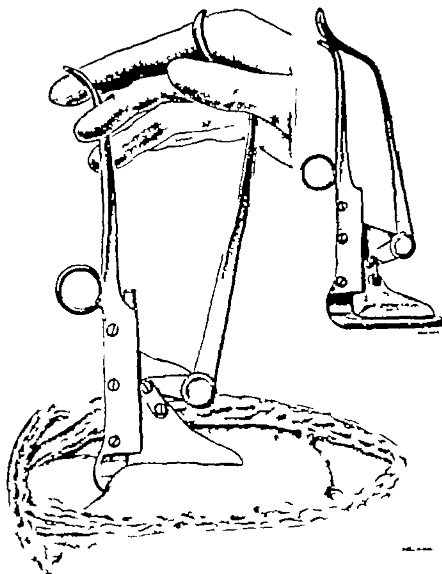


Fig 885.—Division of the sternum with Sauerbruch s sternum splitter (the whole instrument inset)

immediately comes into view Cutting instruments are now laid aside and the pleural membranes are stripped away from the gland on either side with toothless dissecting forceps. This can usually be done without injury to the pleura. Finally the outer edges of the two lobes of the gland are exposed from the root of the neck to the pericardium (Figs 887 888) Vessels entering the gland at its outer edges are divided between clamps and ligatured. When the edges of the glands

are free its under-surface is separated by a finger from the aorta lying beneath it upwards to the left innominate vein and downwards to the pericardial attachments

The next step is to detach each cornu of the gland from the point where it meets the isthmus of the thyroid gland The cornua are

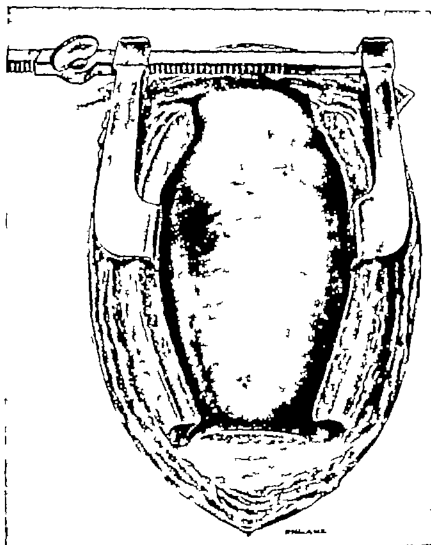


Fig 886.—View of the mediastinum after division of the sternum (the lateral cuts shown are not now recommended) The thymus gland is covered by connective tissue and pleura.

accompanied by blood vessels which must be ligatured. The upper ends of the thymic lobes can now be turned downwards and separated from the surface of the left innominate vein until the vein or veins draining from the under surface of the gland into the innominate vein can be identified, divided between clamps and securely ligatured.

The thymus gland can now be turned down farther its only remaining attachments being to the pericardium. These attachments are not accompanied by blood vessels and can be gradually separated with a

finger great care being taken not to injure the pleura which is in particular danger at this point. When this has been done the gland is completely free and can be removed The object of the operation is total extirpation of the gland and the mediastinum should be

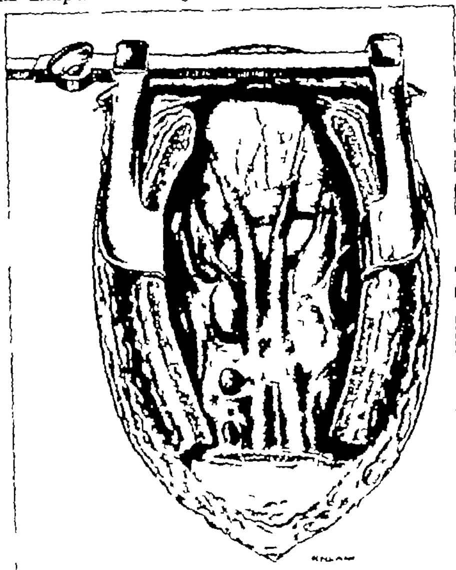


Fig 887 —The thymus gland exposed by dividing connective tissue and stripping back the pleura on each side.

surveyed to ensure that it has been cleared and that there is no bleeding vessel anywhere (Fig 889)

The retractor is now removed and the two halves of the sternum allowed to fall together Accurate apposition of the edges of the bone is obtained by lifting the shoulders forward on the fists of assistants Fixation of the bone is effected by tying three or four sutures of thick chromic catgut passed through the bone by means of a perforated bradawl. The great vessels can be guarded during this manœuvre by a copper strip held behind the bone. Steel wire sutures can be used if the operator prefers but fixation can be effected for a long

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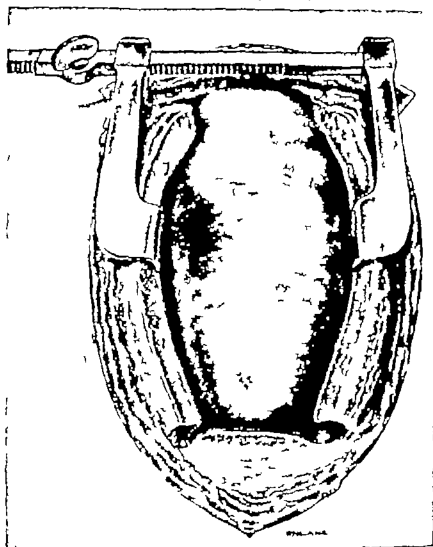


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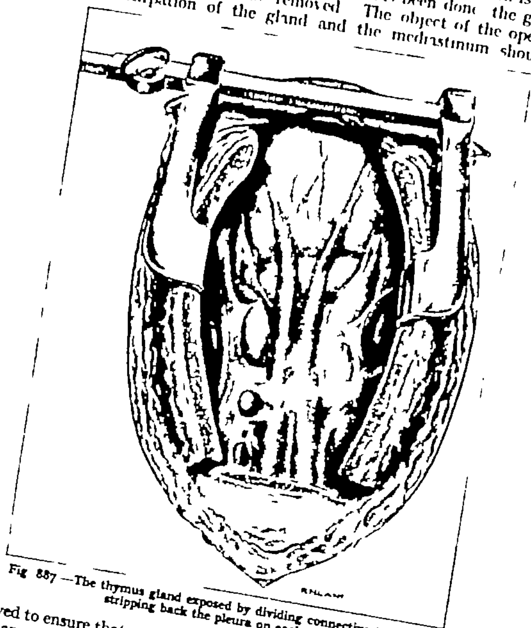


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enough time without introducing this indestructible though brittle foreign body The fixation is then reinforced and the first sutures buried by accurately suturing the periosteum on each half with interrupted sutures of strong catgut The anæsthetist inflates the lungs just before the mediastinal closure is completed to expel any blood that may have accumulated The mediastinum is not drained. The subcutaneous tissues are sutured with fine catgut so that the larger knots

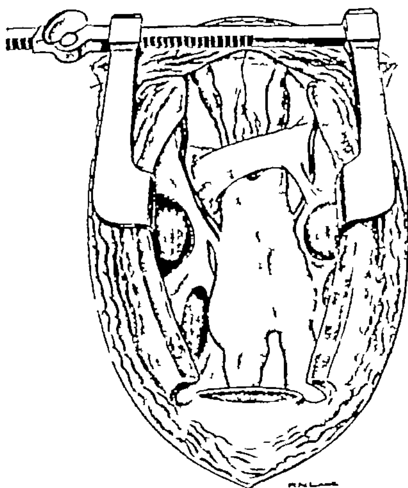


Fig. 888.—Exposure of an abnormal thymus gland which lies behind the left innominate vein.

of the sternal sutures are buried the skin is sutured with horsehair in the neck and fine salmon gut lower down. Clips can be used on the neck but not on the chest wall. Accurate apposition of the skin at the junction of the horizontal and vertical limbs of the incision can be obtained very simply by a horsehair suture securing the upper corners of the latter with another suture passed round the first and through the middle of the upper skin flap A very good scar can be obtained in this way

Gauze dressings are secured with Elastoplast in such a way that there

is no interference with the expansion of the chest afterwards If the myasthenic condition is severe it is usually wise to give the patient 1 mg of neostigmine before leaving the operating table so that there may be full respiratory movement as soon as the effect of the anæsthetic passes off which should happen very soon This dose may be increased or reduced according to circumstances

Post-operative care —This consists in making sure that the patient is having enough neostigmine to maintain the respiratory muscles in

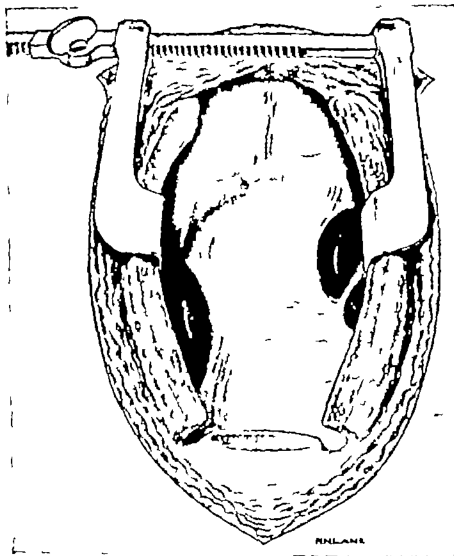


Fig. 889 —View of the mediastinum after removal of thymus, showing thyroid veins, left innominate vein with stump of thymic vein, aorta, and pericardium.

full activity The lungs may be kept clear by deep breathing though the division of the sternum makes this painful at first Forced coughing will help when there is an accumulation of sticky mucus.

Occasionally a patient will have a post-operative myasthenic crisis

necessitating removal of mucus from a bronchus through a bronchoscope and temporary use of a Drinker s apparatus or other means of maintaining artificial respiration.

A blood transfusion is never necessary and all intravenous therapy is to be avoided since extra fluid will tend to increase the secretions from the lungs it is the excessive production of frothy mucus from the lungs in a patient who is unable to cough vigorously that constitutes the chief post-operative danger During the season of colds and influenzal infections myasthenic patients should, if possible be isolated in a separate room and no one should attend on them or visit them without an impervious mask over mouth and nose

X ray pictures of the thorax should be obtained at latest on the day after operation. This with observation of physical signs in the chest will determine whether a pneumo- or hæmothorax is present and whether it should be treated by aspiration Occasionally a pneumothorax is present even though no injury to the pleura was apparent during the operation.

Removal of a Thymic Tumour

A thymic tumour may be removed in the same way as the thymus gland except that the neoplasm may have become adherent to or even have infiltrated surrounding structures so that a complete removal may necessitate excision of portions of one or both pleural membranes (or even of the lung) and of the pericardium If the pleura is opened efforts should be made to close it but this may prove to be impossible If the closure of the thorax is made airtight rapid expansion of the lungs can be effected by aspiration of air from the pleural cavity—so that closure of the pleura though highly desirable is not essential.

Results of thymectomy —The results of the operation are erratic and unpredictable Nevertheless the great majority of the patients benefit greatly many of them being apparently cured. Sometimes the disappearance of the symptoms of myasthenia is so rapid as to be dramatic. At other times it may be some months before the effect is complete Only few patients remain unaffected by the thymectomy so that the operation is usually worth a trial unless the risk is obviously too great The operative mortality has been reduced to 4 per cent

CHAPTER XXXVIII

SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM

By SIR GEOFFREY JEFFERSON and A M BOYD

Introduction.—Since the subject of the surgery of the sympathetic nervous system was first described in these volumes so many data have been collected about the results of sympathectomy in man that a more summary presentation of the subject can be made The mechanisms of the sympathetic nervous system are now so fully covered in physiological text books that no review of the subject is any longer necessary in this work

This section therefore will be found to have resolved itself into a description of the surgery of vascular abnormalities of the limbs of arterial hypertension of hyperidrosis and of certain types of pain Megacolon is known to be more satisfactorily dealt with by excision of the inert segment so that it passes out of this section Although the operations here described have the advantage of being surgical attacks on normal anatomical structures yet some of them are difficult The writers have attempted to help the surgeon by indicating clearly where the difficulties lie and how they can be circumvented in each instance Stress has been laid since this book is concerned with operative surgery upon how the operations should be done and upon the difficulties likely to be encountered rather than upon the clinical indications for the procedures The criteria for sympathectomy vary with the enthusiasm of the individual surgeon and the evolution of new theories of pathogenesis Without further preamble we will proceed to describe the technique of the major sympathectomies

SYMPATHECTOMY FOR THE UPPER LIMB

The results of sympathectomy have never been as satisfactory for the upper limb as for the lower The following reasons have been put forward for the discrepancy First that lumbar sympathectomies owed their success to their being pre ganglionic sections of the fibres which run down the lumbar chain to the sacral ganglia for it is the latter ganglia which are concerned with the innervation of the blood vessels for the major part of the lower extremity This we thought to be important in the light of observations of Telford and the work of White Okeberry and Whitelaw* whose investigations indicated that after pre-ganglionic sympathectomy in the cat the response to circulatory adrenaline was less than half that observable after degeneration of the post-ganglionic fibre As the result of the work of Ascroft†

* E. D Telford, *Brit. Journ Surg* 1935, xxxiii, 448. J C. White, A. M. Okeberry and G P Whitelaw *Arch Neurol. Psychiat* Chicago, 1936, xxxvi, 1251

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it appears that in man the difference is slight The second suggestion put forward was that regeneration of fibres with re-innervation of the vessels was the reason for the difference * It cannot be denied that in experiments on the cat large gaps are undoubtedly bridged quickly Clearly such regeneration would be impossible if the ganglia themselves were removed.

In our experience the most important reason for relapse is incomplete denervation Re-exploration of clinical failures almost invariably reveals intact fibres and in many cases an apparently untouched chain. The temporary success attending imperfect operations is no doubt due to the trauma of unsuccessful search. In those rarer cases where extirpation has been properly performed and yet there has been recurrence of symptoms the reason is to be found in the anatomical researches of Skoog† and Boyd and Munro‡ who found accessory and often minute ganglia far removed from the main chain and even within the spinal canal.

We conclude that there is no reason to invoke either regeneration or sensitization as a cause for failure or relapse. The worse results of upper limb sympathectomy are more simply explained by the greater complexity and wider range of anatomical abnormality in this region. The foregoing was a necessary introduction to our choice of operation Had we any longer held a brief for pre-ganglionic sympathectomy we should have said that it could be done either from the front or the back. The posterior operation as developed by White and Smithwick for pre-ganglionic sympathectomy gives inadequate exposure of the stellate ganglion and as we now favour radical ganglionectomy of the inferior cervical and upper three thoracic ganglia with the intervening chain the anterior approach is essential.

Technique of operation. (*a*) **Anæsthetic.**—Endotracheal anæsthesia is a great advantage because it gives better control of pulmonary pressure should the pleura be injured. The endotracheal tube should be passed through the mouth and not through the nose this is important because after sympathectomy there is considerable congestion of the middle turbinate abrasions of which during the passage of the endotracheal tube may result in troublesome nose bleeding after operation

(*b*) **The operation.**—The position on the operation table is important. The head should be extended by placing a flat sand bag behind the shoulders The chin is turned as far as possible toward the opposite side and the arm pulled down to the side of the patient to depress the point of the shoulder By raising the head of the table it will be found that congestion in the veins of the neck is reduced and in the later stages of the operation the surgeon will be able to look directly down into the mediastinum without having to lean over the patient. Infiltration of the subcutaneous tissues beneath the line of the incision

* H. T. Simmons and D. Sheehan, *Lancet*, 1937 ii, 788.
† T. Skoog, *Lancet*, 1947, ii, 457
‡ J. D. Boyd and P. A. G. Munro, *Lancet*, 1949, ii, 892.

with 0 5 per cent Novocain containing adrenaline 1 200 000 prevents the oozing of blood from the skin edges commonly seen in incisions in the neck The infiltration with local anæsthetic should be carried out before the patient is finally towelled up thus allowing a few minutes for the local anæsthetic to act before the incision is made

The incision is placed about one finger's breadth above the clavicle and extends from the mid point of the sterno mastoid outwards for 2 to 3 inches The platysma muscle is divided through the whole length of the incision and the external jugular vein is divided between

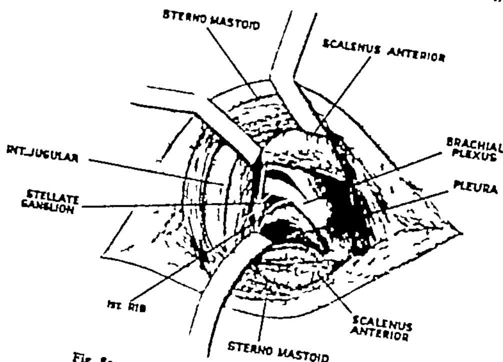


Fig 890.—Anterior approach to stellate ganglion.

ligatures if this should be necessary it is occasionally possible to retract the external jugular vein rather than divide it The outer border of the sterno-mastoid is carefully defined and sufficient muscle divided to give adequate access to the deep structures keeping a careful watch for the internal jugular vein The amount of muscle which has to be divided can be gauged by feeling the underlying scalenus anticus and dividing sufficient muscle to expose its inner border (Fig 890)

Great care must be taken to avoid injury to the internal jugular vein which when collapsed looks like deep fascia. The posterior belly of the omohyoid muscle is then defined and divided The transverse cervical artery and vein which cross the scalenus anticus muscle are sought in the fatty tissue overlying the muscle and divided between ligatures The phrenic nerve is then identified running down the middle of the anterior surface of the scalenus anticus and gently

retracted inwards A second retractor is inserted at the outer end of the wound and the fatty tissue overlying the scalenus anticus pulled upwards and outwards The whole of the surface of the scalenus anticus is now exposed The inner border of the muscle is next carefully defined by blunt dissection upwards and downwards until the first part of the subclavian artery is seen The outer edge is defined in a similar manner great care being taken not to injure the trunks of the brachial plexus which will be seen emerging from under the outer border of the muscle. When both borders of the scalenus anticus have been thoroughly defined it is divided at the level of the upper border of the arch of the subclavian artery The temptation to pass a grooved director under the scalenus anticus muscle and divide the whole sheet in one stroke should be resisted. The muscle at this level is somewhat wedge shaped the apex of the wedge passing downwards between any small branches which may arise from the upper surface of the arch of the subclavian these vessels would almost certainly be collected by the grooved director and divided with the muscle an accident resulting in severe hæmorrhage difficult to control. The muscle should be divided layer by layer with a scalpel until the posterior sheath is seen it is imperative to divide this posterior sheath completely As soon as the posterior sheath has *been entirely divided the cut ends of the scalenus anticus muscle* retract exposing the arch of the subclavian in its second part together with any branches which may arise from it.

The subclavian artery is now cleaned and any branches arising from the upper surface except the vertebral artery are divided between ligatures The subclavian artery is then retracted thus exposing Sibson s fascia. Unless the arch of the subclavian artery is particularly high the authors advise retraction downwards in spite of the trouble entailed in dividing and ligating several small branches frequently found arising from the upper surface of the artery With the normally placed arch retraction upwards makes access to the upper part of the stellate ganglion more difficult and the chance of opening the pleura is increased. Palpation of Sibson s fascia at the inner end of the wound shows a soft area which can easily be broken through by finger pressure revealing the pleura which is gently stripped from the necks of the first three ribs. Access is limited by the medial margin of the first rib a structure very variable in size and shape, but a little more room can be gained by dividing the sharp crescentic tendinous margin of Sibson s fascia on the outer side of the wound after carefully stripping the pleura from its under surface. The subclavian artery and the pleura are now gently held down with a malleable illuminated brain retractor Good illumination is essential at this stage of the procedure and lighted brain retractors are ideal for the purpose

As a rule the lower part of the inferior cervical (stellate) ganglion can easily be seen lying in its groove on the neck of the first rib Occasionally however through an excess of extrapleural fat or poor

illumination the ganglion is not seen but it can be readily identified by palpation A blunt hook is passed underneath the lower part of the ganglion and gentle traction applied This manœuvre makes for easier identification of the sympathetic chain as it runs down the posterior wall of the thorax Maintaining slight traction on the blunt hook the chain is followed downwards by the aid of a blunt dissector until the neck of the third rib is reached The chain is then seized by a pair of long curved tube forceps and a Cushing's or a tantalum clip is placed across the chain distal to the forceps it is then divided between them This precaution is taken in case a small branch of an intercostal artery is closely associated with the chain Gentle traction is now applied to the distal end of the chain and the rami running to the intercostal nerves nipped through until the inferior cervical ganglion is reached

In order to get a better grip the forceps are now removed from the chain and placed across the lower part of the ganglion. Slightly stronger traction is applied and the rami running from the ganglion to the cervical nerves divided until the upper pole of the ganglion is reached. A vein will be seen crossing the waist of the ganglion anteriorly this should be divided between clips Great care should be taken not to injure any other blood vessels Owing to the similarity of small blood vessels to the rami it is wise to divide all apparent rami between two Cushing's clips After making sure of absolute hæmostasis the wound is closed. The divided part of the sterno-mastoid is sutured with one or two thread stitches and the platysma closed with 4XO plain catgut and the skin with fine nylon

Difficulties and their avoidance. (*a*) **Abnormal anatomy**—The main operative difficulty is the risk of damage to important structures chiefly owing to the wide anatomical variations which are encountered It is perhaps a mistake to refer to the normal anatomy of this region The topographical descriptions given in the text books are based on the approximate relationships and variations from these are the rule rather than the exception.

Undescribed arteries and veins may be met at any stage of the operation The arch of the subclavian artery may be very high or very low there may be many branches from its dorsal surface or none at all.

The scalene muscle sheet may not be clearly differentiated into three well-defined muscles the anticus the medius and the posticus. If the scalenus anticus and scalenus medius are fused into one ill-defined muscle mass the surgeon may find himself dissecting deeply into muscle encountering roots of the brachial plexus and finally meeting the transverse processes of the cervical vertebræ The scalene muscles may be normally differentiated but the roots of the brachial plexus may be found in the scalenus anticus and occasionally even superficial to this muscle

Access to the mediastinum may be very restricted owing to

abnormalities of the first rib scoliosis kyphosis or by the presence of cervical rib rudiments or fibrous bands

Because of these anatomical variations it is essential for the operator to have a clear idea of what he has done so far before going on to the next stage Short cuts must be abjured. The operator must always be on the look-out for deviation from the text book descriptions of the topography of the region.

(*b*) **Hæmorrhage.**—If hæmorrhage occurs do not waste time and risk damage to neighbouring structures by plunging wildly into torrents of blood with hæmostatic forceps Pack the wound with a roll of gauze and wait. Remove the gauze after ten minutes and, if there is still bleeding re pack and leave for twenty to thirty minutes. If both sides are to be undertaken it will save time and remove the temptation to take out the pack too soon if the opposite side is proceeded with before returning to the first side and removing the pack. On removal of the pack the hæmorrhage is usually found to have stopped. If there is still a little bleeding the vessel responsible is in most cases easily seen and secured with forceps or Cushing s clips.

There are many possible causes of hæmorrhage which may occur in the course of the operation. If the incision in the sterno-mastoid muscle is carried too far medially the internal jugular vein may be incised in the collapsed state the vein looks like a sheet of fascia. Several large veins may be found and torn during the blunt dissection through the fatty tissue to expose the transverse cervical artery and vein. Careless blunt dissection along the outer and inner borders of the scalene muscles may lead to laceration of large veins at a deeper level this is especially liable to occur along the medial border Severe bleeding then wells up from the depths of the wound making any attempt to secure the bleeding point impossible. It is best to pack the wound and to wait until the bleeding is under control, then the scalene muscle is divided and the bleeding point caught with forceps.

Branches arising from the upper surface of the second part of the subclavian artery may be damaged whilst dividing the posterior layer of fascia ensheathing the scalenus anticus or they may be avulsed from the subclavian artery by forceps or by tugging on the ligatures during the tying of the second half of the knot. This difficulty is best avoided by using a small aneurysm needle rather than applying even the lightest mosquito forceps. If hæmorrhage does occur from these little vessels it is often severe, and any attempt to catch the bleeding point with forceps may damage the subclavian artery itself or the underlying pleura. Packing should be resorted to at once it will be found on removal of the pack a few minutes later that the hæmorrhage has either stopped or has so much diminished that the identification of the bleeding point and its occlusion with a silver clip or ligature is easy

Much worse is damage to the subclavian artery itself which may be injured by retractors. If the artery is retracted too vigorously

especially if it is atheromatous it may crack at the junction of the vertebral artery and the main trunk leading to appalling hæmorrhage. Constant movement of the retractor by an assistant may saw into an atheromatous subclavian artery; this is more likely to occur with retractors which have the illumination fixed to the outer side rather than fused into the middle. Care should be taken to place a little rubber tissue or gauze beneath the retractor and to keep the instrument still. If it is recognized that the main trunk has been damaged the obvious course is to secure it with forceps, divide and ligate the two ends. In the two examples of this disaster seen by one of the authors (A M B) it was not realized that the hæmorrhage was coming from the main trunk itself. The wound was packed but after twenty minutes when the packing was removed the hæmorrhage was still brisk so the patients were returned to the ward with packing *in situ*. The packing was not removed until three days later when it was found that the hæmorrhage had ceased.

In dividing or separating the sympathetic chain from the ribs an intercostal artery or its branches may be severed. Although bleeding may be severe it can be controlled in the usual manner by packing. Hæmorrhage from this source is not serious unless the pleura has been opened; this makes adequate packing impossible and a fatal hæmopneumothorax may occur.

It is the experience of one of us (A M B) that hæmorrhage is most likely to be encountered in the final stages of the operation whilst separating the stellate ganglion. In snipping through the rami behind the ganglion particularly towards its upper end one or more small vessels may be divided. This accident can be obviated by making it a rule to divide between Cushing's clips all apparent rami or suspicious strands of tissue behind the ganglion. If hæmorrhage does occur it is treated in the usual way; it is very important to avoid wild grabs with forceps which may well cause damage to the first dorsal nerve or to the thoracic duct.

(c) **Failure to find the ganglion.**—With adequate lighting failure to find the stellate ganglion is only likely to occur with inexperienced operators. Sometimes however through poor lighting, narrow access to the mediastinum or because of an unusual quantity of extrapleural fat the ganglion may be difficult to see. In this event palpation over the neck of the rib with the finger will identify the ganglion which can then be exposed by blunt dissection.

(d) **Damage to the pleura.**—The pleura may be opened while bursting through Sibson's fascia with the finger during the stripping of the pleura from the neck of the ribs or when the sharp crescentic margin of Sibson's fascia is cut through. Great care should be taken to strip the pleura from the under surface of this tendinous band before dividing it.

Opening the pleura provided the hole is large enough does not matter in the least with competent anæsthesia. The lung is inflated during the suturing of the wound. Opening the pleura never deters

us from proceeding to the opposite side in some cases the pleura has been opened on both sides without any undesirable effects It is rare for there to be more than the thinnest layer of air over the apex of the lung in the post-operative radiograph after this accident provided that the anæsthetist has correctly inflated the lung

The main objection to opening the pleura early in the operation is because of the possibility of hæmorrhage later The mixture of hæmorrhage and an opened pleura is very difficult to cope with packing is of little use so that unless the vessels are secured quickly and permanently hæmo-pneumothorax must result.

(e) **Injury to neighbouring structures.**—Instances of injury to neighbouring structures have been recorded in the literature but are very rare. Among these are damage to the thoracic duct, and removal of a segment of the first dorsal nerve in mistake for the chain. The latter accident is extremely careless and only likely to occur with a very inexperienced operator and poor lighting as the difference in appearance and the relative directions of the two structures make identification easy

Post-operative complications.—The post-operative course is usually uneventful. The stitches are removed after forty-eight hours and the patient is usually fit for discharge on the fifth or sixth post operative day *It is advisable for the arm to be supported* in a sling for the first few days.

(a) **Post-operative pain.**—A certain amount of pain immediately after the operation is not uncommon The patient complains of pain behind the sternum and passing through to the back between the shoulder blades This is due to stripping the pleura from the posterior wall of the mediastinum or to irritation by a small extra pleural blood clot. Simple measures such as hot bottles on the sternum or between the shoulder blades and analgesics such as aspirin, give relief Occasionally the pain is not relieved, which suggests a deep-seated hæmatoma and more adequate analgesia is necessary

A certain amount of brachial neuritis may follow traction of the first dorsal and eighth cervical nerves rarely the higher branches of the plexus are involved. This neuritic pain may last for some weeks and is best controlled by simple analgesics and physiotherapy

(b) **Hæmatoma**—A hæmatoma is occasionally found at the first dressing for the removal of stitches Provided the wound was dry when closed the hæmatoma is usually due to pricking the external jugular vein in stitching the platysma muscle. The treatment is of course evacuation and re-suture

(c) **Dyspnœa.**—Respiratory distress often accompanied by some cyanosis suggests a pneumothorax. The extent of the pneumothorax can be confirmed by X ray and unless causing great distress or a positive pressure pneumothorax it should be left alone If however *there is any doubt about mediastinal displacement* a needle should

be put in the second intercostal space anteriorly and the pressure adjusted to normal

(*d*) **Pleural effusion** —The effusion of blood or blood stained exudate may occur if there is a large pneumothorax Hæmo pneumothorax is sometimes seen where hæmorrhage and opening of the pleura occurred during the operation The treatment is aspiration

(*e*) **Late complications** —An unavoidable outcome of the removal of the stellate ganglion is the production of a Horner s syndrome It is uncommon for this to be so marked as to cause the patient concern although occasionally he is conscious of the drooping of the eyelid This gradually becomes less with the passage of time

Denervation of the sweat glands may lead to excessively dry hands with the skin being liable to develop cracks This can be alleviated by the use of a suitable lanolin preparation

Nasal congestion may sometimes occur especially if there is an enlarged middle turbinate The condition is rarely lasting and recovery is usually complete

SYMPATHECTOMY FOR THE LOWER LIMB

The lumbar sympathetic chain may be approached by two routes the transperitoneal or the extraperitoneal Of these alternatives the extraperitoneal operation only will be described the transperitoneal operation having been abandoned because of a higher incidence of complications and an appreciable mortality Post-operative abdominal distension sometimes of great severity post-operative shock and later incisional herniæ were the principal complications of the transperitoneal operation. The extraperitoneal approach disturbs the patient very slightly and leaves a sound abdominal wall The mortality can be regarded as negligible in our first thousand operations only one patient died coronary thrombosis occurring as he was leaving hospital on the tenth post-operative day Occasional deaths cannot be avoided if the operation is extended to elderly people with advanced arterial disease

Technique of operation (*a*) **Anæsthesia** —Good relaxation is required for this operation General anæsthesia together with a suitable muscle relaxant will fulfil this requirement and give perfectly satisfactory results

(*b*) **The operation.**—The position on the table is most important bad positioning leading to unnecessary difficulties The patient is placed on the operation table in the kidney position and then allowed to incline backwards until his back is at an angle of about twenty degrees to the operation table It is an advantage to raise the bridge or break the table at the level of the lower ribs. The common mistake is having the patient too much on his side The psoas muscle lies surprisingly close to the anterior abdominal wall because of the lordosis of the lumbar spine an anatomical fact apt to be forgotten

Approached through an anterior incision the psoas muscle except in obese persons is only three or four inches deep to the anterior abdominal wall. If the chain is approached from the side however the depth at which it lies is the distance from the skin of the loin to

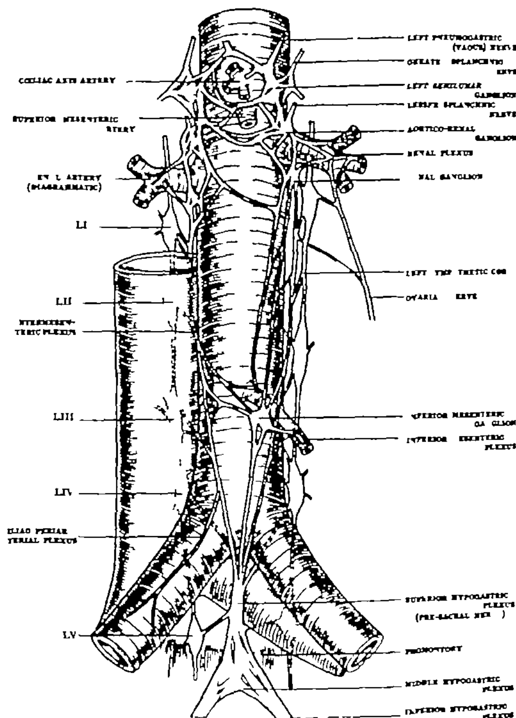


Fig 891 —Anatomy of the lumbar sympathetic system.
(*A A Davis*)

the midline In few operations can the surgeon be so badly handicapped through careless positioning as in lumbar ganglionectomy

An anterior incision is made on a line between the tip of the twelfth rib and a point an inch or so below the umbilicus Beginning about a half inch from the tip of the twelfth rib the incision is made as far as the outer border of the rectus sheath The surgeon is wise not to handicap himself by using too small an incision although it is perfectly possible with experience and in a thin individual to remove the lumbar chain through an incision one and a half inches long The incision described above is four to five inches long in the average sized patient The muscles may be either divided in the line of the incision or split in the direction of their fibres

The gridiron or muscle splitting incision has no advantages whatsoever access is necessarily reduced heavier retraction is required and lighting difficulties occur The muscle-dividing incision especially if the outer border of the rectus sheath is opened gives adequate access and heavy retraction is unnecessary Great care must be taken to incise the transversalis fascia which will be found deep to the transversus muscle and is sometimes mistaken for the peritoneum If stripping is attempted superficial to the transversalis fascia the wrong muscle plane may be entered on the posterior abdominal wall and the sympathetic chain will be concealed by the curtain of fascia in front of it

The peritoneum is stripped from the lateral abdominal wall by careful finger dissection In thin individuals the peritoneum is often rather adherent to the back of the rectus sheath and antero-lateral aspect of the abdominal wall and may easily be torn especially in elderly people On reaching the posterior abdominal wall the peritoneum strips easily to the mid line At the outer border of the psoas muscle the fingers are flexed thus stripping the peritoneum over the rounded border of the muscle until the great vessels are seen. The ureter accompanied by the testicular or ovarian vessels will be seen attached lightly to the peritoneum just before the great vessels are reached. Care must be taken to avoid injury to these structures by careless retraction The kidney in its fascial envelope is swept forwards and upwards with the peritoneum If the position of the psoas muscle is not recalled it is easy to strip the peritoneum as far as the outer border of the psoas and then slip between the psoas and quadratus lumborum muscles The inner margin of the psoas should be exposed from the medial arcuate ligament and diaphragm above to the pelvic brim below (Fig 802.)

The chain is sought in the gutter between the medial margin of the psoas and the vertebral column where it lies on the antero-lateral surface of the lumbar vertebræ directly on the anterior common ligament The rami communicantes to the spinal nerves pass backwards with the lumbar vessels deep to the psoas where the firm chain can usually be felt and rolled under the finger tips branches also pass to the aorta and thus the chain is firmly fixed to the edge

of the anterior common ligament This fact together with the appearance and feel of the chain enables it to be distinguished from other structures in the gutter all of which can be retracted medially and laterally without difficulty Among structures which may possibly be mistaken for the chain are the external iliac and genitofemoral nerves the former having the closer relation to the chain as it runs along the medial margin of the psoas muscle directly lateral to the chain but on an anterior plane. The ureter lies in front of the

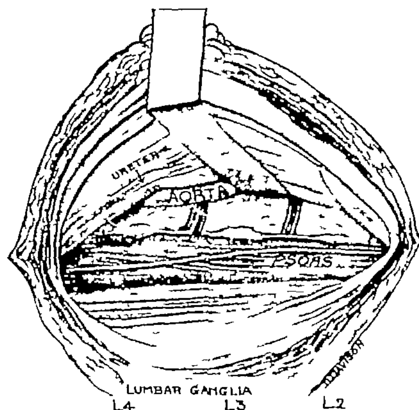


Fig. 892 —Lumbar ganglionectomy

chain but together with the testicular or ovarian vessels it usually adheres to the peritoneum as it is stripped forward. Occasionally however the ureter remains behind lying on top of the chain and despite the fact that it is larger and softer has even been mistaken for it. There are numerous lymphatic trunks in the fatty tissue in the paravertebral gutter and, especially if thickened by inflammation these may bear a superficial resemblance to the chain if the close adherence of the latter to the vertebral bodies is forgotten.

The chain is now exposed from the pelvic brim to the medial arcuate ligament beneath which it passes into the thorax. It is very variable in size and as a rule there are two fusiform ganglia to be seen in the operation field, the so-called second and third lumbar ganglia. In

some cases however it is not easy to distinguish ganglionic masses or possibly only one can be seen The chain is seized in the middle by a pair of long straight forceps and separation begun firstly downwards and then upwards nipping the branches through with long scissors The lower end of the chain is then divided at the pelvic brim The chain is held taut with a pair of forceps and followed beneath the medial arcuate ligament or outer border of the crus as the case may be by dividing overlying muscle fibres of the diaphragm until the whole of the first lumbar ganglion is seen. The upper end of the chain is then divided above the ganglion After oozing has been arrested the wound can be closed in layers without drainage

Difficulties and their avoidance (*a*) **Abnormal anatomy** —Anatomical variations are less frequently encountered and are much less of an operational hazard than in cervico-thoracic ganglionectomy The lumbar vessels are occasionally superficial to the chain and on the right side it is not uncommon for one or more of the lumbar veins to cross anterior to the chain to join the vena cava (*see* Fig 891) Communicating fibres between the ganglia may cross such a vein enmeshing it in nerve fibres which if forgotten may lead to avulsion of the vein from the vena cava A vein is sometimes found immediately deep to the upper part of the lumbar chain or first lumbar ganglion this vein may be very large and represents a coalescence of two or more lumbar veins carrying blood to the azygos vein on the right and the renal vein on the left

The first lumbar ganglion is constant in position but may vary in size The second and third ganglia vary considerably in position and size they may be fused as one large ganglion or distributed in a number of irregular masses of ganglionic tissue As it is necessary to remove the chain from above the first lumbar ganglion to the brim of the pelvis in order to secure complete denervation of the leg * these variations are of academic interest only as there is no occasion on which it is required to remove either the second or third ganglion independently

(*b*) **Hæmorrhage** —The muscle incision described above seldom divides any vessel requiring ligation If the incision is carried backwards into the loin where the muscles are thick and vascular a number of vessels will require ligation The subcostal artery and vein may be divided if the incision is begun too close to the tip of the twelfth rib

Trouble may occur from hæmorrhage from small ganglionic branches of the lumbar vessels which are cut during the separation of the chain Severe hæmorrhage may result from injury to the lumbar vessels themselves or worse still the vena cava may be damaged if badly retracted. In most cases the bleeding point may be caught with forceps and ligated or more simply secured with a Cushing s clip but if this cannot be done immediately time must not be wasted The wound should be packed and the procedure previously described

* A H Ratcliffe and R P Jepson, *Journ. Anatomy* 1950, vii, 97

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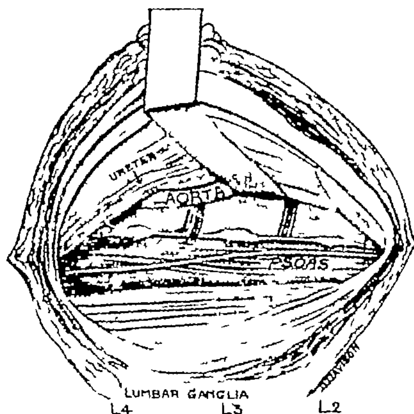


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A. H. Ratcliff and R. J. Jepson, Jour. Neurosurg., 1950, vii, 97.

for arresting hæmorrhage in the course of upper limb sympathectomy carried out

(*c*) **Difficulty in finding the chain.**—The appearance of the chain depends on its size and thickness and the number of ganglionic masses on it which as already mentioned is a very variable factor Even if the characteristic pinkish white ganglia are not seen there should be no difficulty in finding the chain if it is remembered that it lies on the vertebræ. It is recognizable by its firmness to the touch and its lack of mobility because of its fixation by its posteriorly directed branches Overlying the chain in the loose fat are a number of lymphatic vessels and glands which may be enlarged and fibrous. Some of these may have to be removed but if possible it is better not to embark on a gland removal since there is always bleeding from vessels which though small are difficult to secure.

(*d*) **Damage to the peritoneum.**—As has been said the peritoneum is sometimes very thin especially in old people. The peritoneum is normally adherent to the back of the abdominal wall behind the rectus sheath from which it should be gently stripped before beginning the separation laterally If this step is omitted the peritoneum splits at the inner end of the wound.

It is extremely easy to strip the peritoneum off the posterior abdominal wall as far as the outer edge of the psoas muscle and then as has been mentioned, to commit the error of burrowing beneath the psoas until the transverse processes are exposed with the lumbar vessels. Many make this mistake in their first few lumbar ganglion ectomies forgetting that the fingers must be made to slide forward over the surface of this bulky muscle.

Post-operative complications.—In most cases the patient s recovery after lumbar ganglionectomy is completely without incident As a rule the stitches are removed on the eighth day after operation and the patient is ready for discharge from hospital on the tenth day

(*a*) **Post-operative pain**—Stripping the peritoneum during lumbar ganglionectomy appears to give rise to immediate post-operative pain less frequently than does stripping the pleura during cervico-thoracic ganglionectomy There may be slight pain in the loin which can be relieved by simple analgesics. Severe or persistent pain in this area is indicative of a retro-peritoneal hæmatoma.

Some degree of neuritis rarely severe may occur after the patient has returned home and begun to resume activity The patient complains of a burning sensation pins and needles or sharp stabbing pains referred to the inner side of the thigh along the genito-femoral nerve or possibly the external iliac nerve the affected area is hyperæsthetic. The pain begins quite suddenly and disappears equally dramatically usually in ten to fourteen days but occasionally it may last five or six weeks. The pain tends to begin in the evening or at night being minimal during the day when the patient is up and

about. Although discomfort of this type is not uncommon, in only three patients in our series of nearly 2000 lumbar ganglionectomies was the pain severe enough to require the use of more than mild analgesics.

(b) Hæmatoma. A retroperitoneal hæmatoma may occur after lumbar ganglionectomy. Large hæmatomata in the retro-peritoneal tissue track forward and disrupt the wound; there may be severe loss of blood. The patient complains of severe pain in the loin and the dressings are seen to be stained. Hæmatoma of this type usually occurs within the first six hours after operation. The wound must be re-opened, the clot evacuated and the bleeding vessel ligated. Sometimes slow oozing in the retroperitoneal tissues leads to a large hæmatoma which finally disrupts the wound between the fifth and eighth days.

Some slight abdominal distension is quite frequently seen after the operation, but if there is severe distension accompanied by vomiting, a retroperitoneal hæmatoma must be suspected. The ileus recovers in a day or two if the patient is given his fluids parenterally and gastric suction employed.

Even in cases in which hæmostasis has been complete, small hæmatomata arising in the abdominal wall are occasionally found when the stitches are removed. These hæmatomata are undoubtedly brought about by dragging the patient up the bed by the armpits instead of carefully lifting him.

(c) Other complications. Lumbar ganglionectomy is most frequently carried out on patients who have arterial disease to a greater or less extent. It is not surprising, therefore, that the occurrence of a complication of arterial disease sometimes coincides with the period of the patient's stay in hospital or convalescence. In our series there have been seven instances of cerebral thrombosis occurring in this period and this number is far too small for us to hazard an opinion as to any part the operation may have played as a precipitating factor.

As we have said, it is necessary to remove the first lumbar ganglion to secure a satisfactory sympathetic denervation of the lower limb. There have been objections, based on the after-effects of thoraco-lumbar sympathectomies, that removal of the first lumbar ganglion would sterilize the patient. Rose* has shown conclusively that this is not the case; in order to produce sterility the lower thoracic ganglion must also be removed.

SYMPATHECTOMY FOR HYPERTENSION

Numerous operations have been designed for the relief of hypertension ranging from the limited sub-diaphragmatic resection of the splanchnic nerves and upper lumbar ganglia advised by Craig† and the equally limited supra-diaphragmatic operation used by Peet‡ to the

* B. R. Rose, Brit. Med. Journ., 1953, i, 247.
† W. McK. Craig, West. Journ. Surg. Obst. Gyn., 1934, xlii, 146.
‡ M. M. Peet, Univ. Hosp. Bull. Ann Arbor, 1935, i, 17.

*total sympathectomy advocated by Grimson.** *In the writers opinion* the middle course steered by Smithwick guides the surgeon through the confusion resulting from the innumerable operations advocated in the last fifteen years. Smithwick s operation accomplishes the three generally recognized objects of sympathectomy for hypertension — it causes vasodilation in the splanchnic areas and the lower extremities it denervates the suprarenal gland it prevents vasoconstrictor influence from reaching the kidney

The essential feature of Smithwick s thoraco-lumbar splanchnicectomy *is the division of the diaphragm which gives access to the* no-man s land which lies behind the diaphragm in front of the bodies of the eleventh and twelfth dorsal vertebræ. This region tends to be missed in both the thoracic and lumbar approaches. The retro-diaphragmatic region in front of the bodies of the eleventh and twelfth



Fig. 893.—Splanchnic sympathectomy Smithwick operation, left side, before division of diaphragm and crus, showing the three splanchnics.

dorsal vertebræ is in our opinion a key area where splanchnic nerves sympathetic chain and numerous twigs passing from the aortic and sub-diaphragmatic plexuses intermingle Smithwick s operation has rightly become the standard procedure and will be the only operation described in detail. There have been a number of minor modifications in this operation which are relatively unimportant and are largely matters for individual preference. Smithwick *himself gains access* by resecting the twelfth rib Learmonth chooses the eleventh rib and we also prefer the eleventh rib Smithwick uses the extrapleural approach stripping the pleura from the upper surface of the diaphragm and from the necks and heads of the lower ribs. But since most surgeons accidentally open the pleural cavity at some stage of the operation, we feel that it is better to open it deliberately The advantages of the transpleural operation are that it is quick the suturing of the diaphragm is very much simpler because the pleura helps to hold the stitches well opening the pleural cavity causes less shock than does stripping the pleura from the posterior thoracic wall. Furthermore if there does happen to be an intra thoracic collection of blood after the operation it is better to have it in the pleural cavity where it will remain fluid and easy to aspirate rather than to have clotted blood in the extrapleural tissues.

* K. S. Grimson, Ann. Surg 1941 July 783.

Technique of operation. (a) *Anaesthesia.*—General anaesthesia is recommended. Nitrous oxide, oxygen and ether or trilene is used and great attention paid to oxygenation. Patients in the malignant phase of the disease run a great risk of cerebral anoxia if there is a sudden or prolonged fall of blood pressure during the operation. It is better therefore to maintain the blood pressure at pre-operative level during the operation, allowing it to fall gradually afterwards. Any tendency for the blood pressure to fall can be counteracted by the injection of pressor drugs and particularly during the operation on the second side by the infusion of Dextraven.

(b) *The operation.*—The patient is placed on the operation table in the kidney position with the side to be operated upon uppermost. The surgeon stands facing the patient's back. The patient is then inclined about forty degrees towards the surgeon and supported in this position by sand bags beneath the buttock and shoulder blade.

The incision begins at the outer border of the erector spinae over the posterior end of the eleventh rib and is carried forward in line of the eleventh rib throughout its entire length continuing in the same line as far as the outer border of the rectus sheath. The first step in the operation is resection of as much of the eleventh rib as possible. The incision is deepened through the overlying muscles along the line of the ribs. At the posterior end of the incision the outer inch of the sheath of the erector spinae is opened and the muscle retracted towards the mid line. The rib is divided as far back as possible. With nibbling forceps the proximal end of the rib is removed as far back as the costo transverse joint.

The thoracic wound is now covered with a moist pack and attention turned to the abdominal wound. The incision is deepened through the three abdominal muscles and transversalis fascia as far as the outer border of the rectus sheath which is incised thus exposing the rectus muscle. The peritoneum is then stripped backwards from the lateral and posterior abdominal wall and from the under surface of the diaphragm. The kidney in its fascial envelope is retracted upwards and forwards. The dissection is carried over the surface of the quadratus lumborum and psoas muscles to the sides of the first and second lumbar vertebrae. The sympathetic trunk is then identified along the inner border of the psoas muscle. It is followed downwards and divided below the third lumbar ganglion. The proximal end of the cut chain is held with artery forceps and the chain mobilized upwards by dividing its branches as in the ordinary operation of lumbar ganglionectomy. The chain will be seen to disappear beneath the internal arcuate ligament. The crus is easily cleared by finger and gauze dissection and the retractor in the upper part of the wound is moved so as to exert a more upward pull.

The greater splanchnic nerve is next identified where it perforates the upper part of the crus; the nerve often appears in the form of several strands close together all coming through the same opening distinctly above and external to the lumbar chain. It is a large nerve

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The essential feature of Smithwick s thoraco-lumbar splanchnicec tomy is the division of the diaphragm which gives access to the no-man s land which lies behind the diaphragm in front of the bodies of the eleventh and twelfth dorsal vertebræ This region tends to be missed in both the thoracic and lumbar approaches. The retro-diaphragmatic region in front of the bodies of the eleventh and twelfth



Fig 893 —Splanchnic sympathectomy Smithwick operation, left side, before division of diaphragm and crus, showing the three splanchnics.

dorsal vertebræ is in our opinion a key area where splanchnic nerves sympathetic chain and numerous twigs passing from the aortic and sub-diaphragmatic plexuses intermingle Smithwick s operation has rightly become the standard procedure and will be the only operation described in detail. There have been a number of minor modifications in this operation which are relatively unimportant and are largely matters for individual preference. Smithwick himself gains access by resecting the twelfth rib Learmonth chooses the eleventh rib and we also prefer the eleventh rib Smithwick uses the extrapleural approach, stripping the pleura from the upper surface of the diaphragm and from the necks and heads of the lower ribs. But since most surgeons accidentally open the pleural cavity at some stage of the operation, we feel that it is better to open it deliberately The advantages of the transpleural operation are that it is quick the suturing of the diaphragm is very much simpler because the pleura helps to hold the stitches well *opening the pleural* cavity causes less shock than does stripping the pleura from the posterior thoracic wall. Furthermore if there does happen to be an intra thoracic collection of blood after the operation it is better to have it in the pleural cavity where it will remain fluid and easy to aspirate rather than to have clotted blood in the extrapleural tissues.

* K. S. Grimson, *Ann. Surg* 1941, cxiv 753.

Technique of operation (*a*) **Anæsthesia**—General anæsthesia is recommended nitrous oxide oxygen and ether or trilene is used and great attention paid to oxygenation Patients in the malignant phase of the disease run a great risk of cerebral anoxia if there is a sudden or prolonged fall of blood pressure during the operation It is better therefore to maintain the blood pressure at pre-operative level during the operation allowing it to fall gradually afterwards Any tendency for the blood pressure to fall can be counteracted by the injection of pressor drugs and particularly during the operation on the second side by the infusion of Dextraven

(*b*) **The operation**—The patient is placed on the operation table in the kidney position with the side to be operated upon uppermost The surgeon stands facing the patient s back The patient is then inclined about forty degrees towards the surgeon and supported in this position by sand bags beneath the buttock and shoulder blade

The incision begins at the outer border of the erector spinæ over the posterior end of the eleventh rib and is carried forward in line of the eleventh rib throughout its entire length continuing in the same line as far as the outer border of the rectus sheath The first step in the operation is resection of as much of the eleventh rib as possible The incision is deepened through the overlying muscles along the line of the ribs. At the posterior end of the incision the outer inch of the sheath of the erector spinæ is opened and the muscle retracted towards the mid line. The rib is divided as far back as possible With nibbling forceps the proximal end of the rib is removed as far back as the costo-transverse joint

The thoracic wound is now covered with a moist pack and attention turned to the abdominal wound. The incision is deepened through the three abdominal muscles and transversalis fascia as far as the outer border of the rectus sheath which is incised thus exposing the rectus muscle The peritoneum is then stripped backwards from the lateral and posterior abdominal wall and from the under surface of the dia phragm The kidney in its fascial envelope is retracted upwards and forwards The dissection is carried over the surface of the quadratus lumborum and psoas muscles to the sides of the first and second lumbar vertebræ The sympathetic trunk is then identified along the inner border of the psoas muscle it is followed downwards and divided below the third lumbar ganglion The proximal end of the cut chain is held with artery forceps and the chain mobilized upwards by dividing its branches as in the ordinary operation of lumbar ganglionectomy The chain will be seen to disappear beneath the internal arcuate liga ment The crus is easily cleared by finger and gauze dissection and the retractor in the upper part of the wound is moved so as to exert a more upward pull.

The greater splanchnic nerve is next identified where it perforates the upper part of the crus the nerve often appears in the form of several strands close together all coming through the same opening distinctly above and external to the lumbar chain It is a large nerve

and is readily found by sweeping a finger down the crus until it is arrested by the emergence of the nerve. After a course of about two centimetres it ends in the cœliac ganglion.

If the internal arcuate ligament and the crus of the diaphragm are incised upwards using the lumbar gangliionated chain as a guide both that chain and the greater splanchnic nerve can be followed up above the diaphragm. Moreover the lesser of these splanchnic nerves come into view very clearly as they run along the body of the twelfth thoracic vertebræ (Ross) The advantage of carrying the dissection so high from below is that the line where the diaphragm should be divided now becomes plain The nerve trunks already isolated have been clearly identified below the diaphragm and they can now be discovered without loss of time in the posterior mediastinum.



Fig. 894.—Ross's modification long incision of crus to allow good access to the splanchnics from below

The surgeon next turns to the thoracic dissection opening the pleural cavity along the line of the eleventh rib at the posterior end of the wound The dome of the diaphragm is now in full view the peritoneum has been stripped from its under surface and the upper surface exposed by opening the pleural cavity By retracting the lung upwards and inspecting the thoracic cavity the sympathetic chain is easily seen lying on the necks of the ribs and further medially the greater splanchnic nerve communicating with the chain by numerous branches The pleura is now incised over any of the lower dorsal sympathetic ganglia. Using long scissors the chain is followed upwards as high as is desired as a rule as far as the eighth thoracic ganglion, where it is divided and the upper end marked by a silver clip The chain is then followed in a downward direction as far as the upper surface of the diaphragm. The medial edge of the parietal pleura is seized with long artery forceps and dissected medially as a flap until the greater splanchnic nerve is seen. The nerve is then mobilized by snipping through its branches to the aorta and from the thoracic sympathetic chain dividing them as high as possible. The nerve is then freed downwards as far as the upper border of the diaphragm. The attachment of the diaphragm to the twelfth rib is now divided, the section being continued as far as the greater splanchnic nerve and sympathetic chain This lays bare the complete field the thoracic and lumbar sympathetic chains are seen in continuity and the whole course of the splanchnic nerve is visible.

Hæmostasis is secured any oozing from the posterior thoracic wall is most easily controlled by Oxycel gauze. The diaphragm is sutured with interrupted sutures of fine silk and as the closure approaches the abdominal wall the digitations of the transversus and the cut intercostal muscles of the eleventh space are included in the sutures. The

suturing is continued into the abdominal wall closing the abdominal half of the wound in layers. The anaesthetist is then asked to inflate the lung as the thoracic half of the incision is closed. As soon as it is seen that the lung is fully expanded the wound is closed without drainage.

Difficulties and their avoidance.—The Smithwick operation is essentially an extended lumbar ganglionectomy and the difficulties listed under the previous section are therefore to be considered in

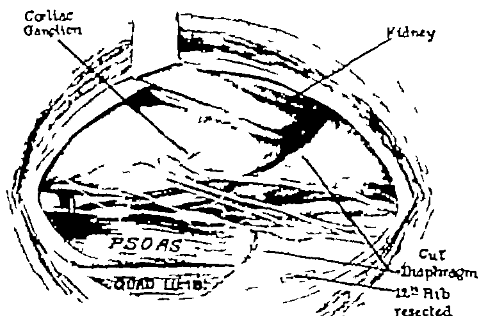


Fig. 895.—Splanchnic sympathectomy. The complete field dissected out and diaphragm divided.

this procedure also. However, the carrying out of the operation as described above means that the chain is visible in continuity throughout the operation field and so the difficulties which may be encountered in lumbar ganglionectomy are less likely to occur in the Smithwick operation. Attention should be drawn to two possible sources of difficulty in the thoracic part of the operation. Branches of the intercostal vessels enter the ganglia on the under side and great care must be taken to secure them when the ganglia are freed, otherwise, in spite of their small size, there will be troublesome bleeding. The intercostal vessels themselves cross immediately deep to the chain and there is a risk of their being damaged during the freeing of the chain.

Post-operative complications.—The Smithwick operation is liable to result in a number of post-operative complications in addition to those described following lumbar ganglionectomy.

(a) **Post-operative pain.**—There is usually more or less severe pain in the region of the thoracic incision occurring in the immediate post

operative period It is essential to provide adequate analgesia to over come this. Persistence of the thoracic pain leads to shallow breathing which accentuates pulmonary difficulties. The reduced oxygenation of the blood in association with reduced blood pressure may result in cerebral and cardiac complications which would otherwise have been avoided

(*b*) **Pulmonary**—Atelectasis residual pneumothorax or pleural effusion are not uncommon post-operative complications With the lung expanded by positive pressure while the chest is being closed, a negligible amount of air should be left in the pleural cavity the extent of pneumothorax and degree of atelectasis is largely dependent upon the skill of the anæsthetist. In most cases the lower lobe expands and the pneumothorax is absorbed in a few days. A small basal effusion was shown by the post-operative radiograph in many cases but it was rarely large enough to demand aspiration.

(*c*) **Cerebral.**—Post-operative cerebral complications are in a great measure due to a sudden or prolonged fall in blood pressure occurring during operation. This is particularly true of patients in the malignant phase of hypertension Two patients in our series died from cerebral anoxia in the first twenty four post-operative hours without recovering consciousness coma deepened breathing became more stertorous and increasing paralysis of the limbs was noticed within a few hours of operation.

Cerebral thrombosis is surprisingly rare as a post-operative com plication The onset is usually gradual, hemiplegia beginning after twenty four hours from the thrombosis. Complete recovery is the rule. Some degree of mental confusion may accompany the post-operative hypotension but the symptoms usually disappear within a week to ten days

(*d*) **Other complications.**—The remarks made in the section on lumbar ganglionectomy about the type of patient who is submitted to operation are even more applicable here. The attainment of the desired fall in blood pressure presents a different set of conditions to the cardiovascular system from those under which it has been working It is not surprising therefore that congestive heart failure or coronary thrombosis is occasionally seen in the post-operative period. Renal failure although extremely rare is not unknown. When the patient first gets out of bed he experiences postural hypotension tachycardia and dyspnœa but as a rule these phenomena cease to be troublesome after a few weeks although some tachycardia may persist.

The bilateral removal of the lower thoracic and lumbar ganglia will result in sterility in the majority of male patients (Rose *loc cit*) and in some there may be temporary or permanent loss of erection.* There are no analogous effects in women.

J C. White and R. H. Smithwick, 1942. Autonomic Nervous System, p. 87 Henry Kimpton.

SYMPATHECTOMY FOR THE RELIEF OF PAIN

Afferent fibres mediating visceral pain travel towards the spinal cord in association with sympathetic fibres. These pain-conducting axons pass through the sympathetic ganglia without interruption to reach their cell stations in the dorsal root ganglia of the spinal nerves. In conditions in which persistent visceral pain calls for neurectomy removal of the appropriate part of the sympathetic nervous system provides a convenient method of interrupting these afferent fibres. Thus pain of renal origin is most conveniently relieved by removal of the lumbar ganglia and resection of the splanchnic nerves below the diaphragm. It is not proposed to discuss the many operations of this type which have been described but to limit ourselves to the procedure for the relief of angina pectoris.

Angina pectoris.—The successful relief of angina pectoris was described by Jonnesco* who removed the middle cervical and stellate ganglia on the left side in order to interrupt the afferent pathways from the heart. On the other hand Coffey and Brown† obtained good results in certain cases by removal of the left superior cervical ganglion alone, a procedure which interrupts some of the cardio-accelerator nerves but leaves the afferent fibres virtually intact. From our own experience we feel that interruption of the afferent pathways from the heart is essential and that the efferent pathways should be interrupted not only to reduce cardio-pressor effects but also to denervate the coronary vessels themselves. Adequate afferent and efferent denervation can be achieved by a cervico-thoracic ganglionectomy extended to include the first four thoracic ganglia and in our opinion this is the operation of choice.

The anæsthesia to be used depends considerably on the condition of the patient. Basal anæsthesia with rectal paraldehyde supplemented with nitrous oxide and oxygen is satisfactory. Whatever anæsthetic is used great attention must be paid to the oxygenation.

The operation is carried out through the anterior supra-clavicular approach in a manner similar to that described in the section on cervical sympathectomy. Unless the patient is an exceptionally good operational risk only one side should be undertaken at a time. The left side is operated upon first; occasionally this is enough to relieve the pain but usually both sides must be denervated before complete relief is obtained. The technique of the operation is exactly the same as that described previously but even more precautions must be taken to avoid opening the pleura as pneumothorax or other respiratory upset leading to dyspnœa and anoxia is extremely undesirable. The subclavian artery is almost certain to show atheromatous changes and is thus all the more liable to injury during retraction; pledgets of gauze soaked in saline should be placed between the artery and the retractor.

As soon as the patient has come round from the anæsthetic he should

* T. Jonnesco, *Presse Méd.*, 1921, xxix, 193.
† W. H. Coffey and P. K. Brown, *Arch. Int. Med.*, 1923, xxxi, 200.

be allowed to take up the position in which he can breathe most comfortably, a semi-sitting position is usually best. It is probably wise for the first forty-eight hours to be spent in an oxygen tent. At the end of this period he is removed from the tent and he can be allowed up the following day if his cardiac condition permits.

Additional post-operative complications to those already described are congestive heart failure and coronary thrombosis. The operation can throw a heavy burden on a heart muscle already damaged by infarction and further thrombosis may occur so inducing rapid death. On the whole, however, these happenings are not frequent enough to act as deterrents.

PARAVERTEBRAL BLOCK

A paravertebral block of the sympathetic outflow to the limbs, using local anaesthetics, is of value for the estimation of the probable results *of sympathectomy and for the treatment of certain conditions. It is* essential to carry out a paravertebral block before embarking on a sympathectomy for the relief of post-traumatic painful states, as clinical assessment may be misleading and even the most experienced clinician should confirm his opinions before operating. In some of these cases the relief of pain far outlasts the effect of the local anaesthetic and may even be permanent. A stellate ganglion block may give complete and permanent relief of symptoms and bring about rapid resolution in acute thrombosis of the axillary vein. Similarly a paravertebral block of the lumbar ganglia with procaine will give symptomatic relief and cause resolution of the œdema of acute deep phlebitis of the calf and ilio-femoral thrombosis, thereby preventing the sequal of phlegmasia alba dolens. It must be emphasized that a block for the treatment of acute deep phlebitis should be carried out as soon as possible after the incident; if it is done within twelve hours relief is virtually certain. It is worth while carrying out treatment within twenty-four hours of the event and possibly even later, but if the initial vasospasm has decreased, as shown by a warm hand or foot, a block is no longer likely to be of benefit.

In those patients for whom a lumbar ganglionectomy is indicated but whose general condition precludes operation a considerable degree of sympathetic denervation can be achieved by means of a paravertebral block with phenol. Several writers have advocated chemical neurectomy with alcohol but this is often followed by a painful neuritis. Haxton* has shown that the use of phenol is without painful sequelæ. It is unwise to use phenol for a stellate block owing to the possibility of damage to *important neighbouring* structures from the subsequent fibrosis.

Technique of paravertebral block. (*a*) For the upper extremity.—The most suitable local anæsthetic for a stellate ganglion block is procaine mixed with a buffering solution. The patient sits in a chair

* H. A. Haxton, *Brit. Med. Journ.*, 1949, 1, 1026.

with the head and neck flexed The spinous processes of the seventh cervical and first thoracic vertebræ are identified and an intradermal wheal is raised with 2 per cent procaine 4 cm lateral to the mid point between them An 8-cm Labat needle is passed through this point at an angle medially of 20 deg until the first rib or first thoracic transverse process is felt usually at a depth of between 3 and 4 cm The point of the needle is passed beneath the transverse process and injection begun in order to strip up the pleura The side of the body of the first thoracic vertebra is felt after advancing the needle a further 3 cm or so and 10 ml of 2 per cent procaine are injected

(*b*) **For the lower extremity** —Buffered procaine is again the most suitable local anæsthetic for carrying out a temporary block of the lumbar ganglia or as a test injection before a chemical sympathectomy with phenol

The patient lies on his side and a pillow is placed under the loin in order to separate the transverse processes widely It is important that the back should be kept straight avoiding either flexion or extension and that the trunk should be in a strict lateral position at right angles to the bed, the foot of which is raised on 10-in. blocks This is to encourage seepage upwards of the injected fluid along the tissue planes around the sympathetic chain to reach the first lumbar ganglion In the case of a chemical sympathectomy the bed clothes are removed so that the legs are exposed to room temperature preferably about 20° C and frequent readings are taken of the skin temperature on the inner side of the heel until a steady level is reached

After skin preparation and isolation of the lumbar region with sterile towels an intradermal wheal is raised with 2 per cent procaine at a point near the outer border of the erector spinæ lateral to the spine of the second lumbar vertebra. A 16-cm needle is most commonly used but a 12-cm needle is adequate in small and thin individuals. The needle is passed through the selected point medially at an angle of 80 deg from the horizontal plane The operator should make a mental picture of the erector spinæ and psoas muscles and the vertebral bodies drawing an imaginary line from the point of injection to the front of the body of the second lumbar vertebra. The needle may pass lateral to the tip of the transverse process but it is preferable that the transverse process should be felt and the needle withdrawn a little inclined slightly upwards or downwards to pass above or below the bone and then advanced some 4 centimetres through the psoas muscle until the antero-lateral aspect of the vertebral body is reached. Occasionally the needle passes in front of the vertebral body and pierces the aorta or vena cava a harmless event serving as a useful indication of the position of the needle point which is then withdrawn and reinserted at a greater angle until bone is felt When the needle is considered to be in close proximity to the lumbar chain careful aspiration is carried out to make quite certain that the spinal theca or a blood vessel has not been entered. For a temporary

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block of the lumbar ganglia 20 ml of 2 per cent. procaine are injected.

If the procedure is for chemical sympathectomy a test injection of 2 ml. of procaine is made and the skin temperature is continuously observed. Although a large rise in skin temperature cannot be expected in patients with advanced arteriosclerosis if the needle is correctly placed there should be a rise of 1° C. within three minutes. If there is no alteration in skin temperature the needle should be withdrawn and reinserted at a different angle and the test injection repeated. Only when the operator is completely satisfied that the needle is correctly placed should 10–15 ml. of a 10 per cent. aqueous solution of phenol be injected. The injection fluid may be cloudy owing to the phenol not being completely in solution at room temperature in which case the bottle should be placed in warm water until the solution is clear and the syringe also should be warm. The patient should remain in the lateral position for 20 minutes in order to keep the pool of phenol in contact with the lumbar ganglia and then he may be turned on his back and the blocks removed from the foot of the bed He should remain flat on his back for an hour after which he may return home by car or ambulance with instructions to lie down for the rest of the day

No complications of any importance have been observed after chemical sympathectomy and none will be if the surgeon aims at the anterior border of the lumbar vertebræ slanting his needle well forwards.

THE APPLICATIONS AND RESULTS OF SYMPATHECTOMY

In the introductory remarks to this chapter we mentioned that the accepted indications for sympathectomy vary with current theories on the pathogenesis of some of the conditions for which sympathectomy has been advocated and with individual interpretation of these theories. So far certain procedures have been described and we now propose to discuss the general effect of these procedures and the possibilities of their success in the treatment of selected patients. It is hoped that showing the possibilities and limitations of sympathectomy will be of more value to the clinician in deciding the chances of an operation being of benefit to a particular patient than would a list of indications and contra indications as they exist at the time of writing

Firstly let us consider the general effects of sympathectomy Removal of vasoconstrictor tone results in dilatation of the blood vessels and a corresponding increase in blood flow In the limbs this increase is maximal during the first few days after operation and thereafter gradually decreases. This appears to be due to a return of some degree of vascular muscle tone even in the absence of impulses from the vasoconstrictor nerves.

It has been suggested that this return of tone is brought about by

response to circulating adrenaline but this is far from proven A certain parallel occurs in the sweat glands in which sympathectomy abolishes normal thermo-regulatory sweating but the denervated glands show no signs of atrophy The sweat glands are not adrenergic but cholinergic and as far as we are aware it has not been suggested that the glands are maintained by circulating acetylcholine A great deal of stress has been laid upon the undeniable fact that the immediate effects of sympathectomy are not maintained. In itself this is largely academic The important facts that emerge are that there is a maximal dilatation immediately after sympathectomy that vascular tone is reduced and that there is a residual increase of blood flow above the pre-operative level even though it may only be slight

The advantages of being able to obtain a maximal blood flow even for a few days are obvious in the acute stage of an obliterative vascular lesion. From purely mechanical considerations the reduction in vascular tone will aid the opening up of the collateral circulation especially round a main arterial block Even though the residual increase may not be very great it often happens as Ross* has pointed out that this increase is sufficient to turn the scales in the patient's favour Apart from any effect on the nutritional state of the limb an increased blood flow will result in the more effective removal of pain producing metabolites and will thus give symptomatic improvement in conditions in which these play a part Unusually high sympathetic activity is of course also abolished and this can be used to advantage in conditions such as hyperidrosis and those in which there may be vascular hypertonia.

With these considerations in mind let us examine the practical application of sympathectomy to some general groups of conditions in which it is widely used Where results are given they are intended to provide the clinician with a general guide to the chances of success in dealing with a particular problem In no other surgical procedure do the statistical figures depend so much on the methods employed for selection and assessment and so figures are only quoted where they are based on well-defined criteria

Acute occlusion of a limb artery—Under certain circumstances usually as a result of trauma ligation of a main artery supplying a limb may be necessary Such a procedure inevitably carries a risk of gangrene but sympathectomy will provide the necessary increase in blood supply to the limb to tide the patient over the acute ischæmic phase and aid the development of the collateral circulation Sympathectomy should accompany ligation in emergency cases and precede it in planned operations On no account should sympathectomy be deferred to a subsequent operation a few days later when it is obvious that gangrene is imminent because some of the peripheral vessels will be already occluded and vasoconstrictor release may short-circuit the blood proximally thus precipitating the condition it is desired to

* J Paterson Ross, Ann. Roy Coll. Surg., 1952 xi, 386.

avoid. In one of the authors (A M.B) series of 45 cases of main vessel ligation—which includes ligation of the common femoral external iliac triple ligation of the common and superficial femoral and profunda and popliteal arteries—there has been no incidence of gangrene.

Occasionally arterial thrombosis is seen as a result of a traumatic incident such as posterior dislocation of the knee joint. The risk to the limb in these cases is the failure to develop an adequate collateral circulation and sympathectomy should be carried out as soon as possible after the incident

Obliterative arteritis of the legs.—Diminution of the blood supply to the legs is most commonly associated with degenerative changes in the arteries the pathological conditions usually being somewhat haphazardly classed as either arteriosclerosis obliterans or thromboangiitis obliterans. We prefer to class all types of obliterative arterial disease of the leg which have an arteriosclerotic background under the term senile obliterative arteritis as opposed to juvenile obliterative arteritis which is restricted to the more rigid original description of thromboangiitis obliterans and is characterized by fungoid infection of the feet and an associated superficial phlebitis.

The symptom of senile obliterative arteritis most frequently seen is intermittent claudication due to the blood flow through the active muscle being below the level necessary to prevent the metabolic products accumulating above the pain threshold. A sympathectomy carried out for the relief of intermittent claudication will be successful if the blood flow is increased above the critical level and will fail if this result is not achieved. It is thus essential to use great care in the selection of patients for sympathectomy if the relief of intermittent claudication is the sole purpose of the operation. In practice many other factors must be taken into consideration and relief of intermittent claudication may be only incidental to the main purpose. (For details of the criteria of selection and assessment see Boyd *et al* and Boyd *) In the Manchester Neurovascular Clinic we have seen some 2 000 cases of obliterative vascular disease and of these sympathectomy for the relief of intermittent claudication was carried out in just under 300 cases with early satisfactory improvement in between 75 and *80 per cent Five years later the improvement had fallen to 45 per cent* As the years pass these patients certainly deteriorate but that is to be expected. The early improvement is none the less well worth while.

Even when there is no chance of relieving the intermittent claudication sympathectomy may be performed to improve the nutrition of the limb in an attempt to stave off amputation. Similarly sympathectomy is advisable in cases of juvenile obliterative arteritis not only to give the maximum increase in blood supply but also by abolishing sweating to dry the feet and discourage the fungus infection.

A. M. Boyd, *Medical Press*, 1954 ccxxxi, 170. A. M. Boyd, A. H. Ratcliffe, R. P Jepson and G. W H. James, *Journ. Bone Jt. Surg.*, 1949, xxxiB 325.

Erythrocyanoid states.—In erythrocyanosis frigida angiography shows arteries and veins of less than average calibre and in extreme cases femoral arteries have been observed of the size of the average radial artery There is little doubt that the characteristic phenomena of this condition result from congenital hypoplasia of the vascular system In the more severe cases which fail to respond to chemotherapy a timely sympathectomy will do much to improve the patient s comfort and prevent the distressing and unsightly swelling of the legs

Erythrocyanoid phenomena are sometimes observed following anterior poliomyelitis the lack of vasodilator stimuli from the paralysed muscles leading to a secondary hypoplasia of the blood vessels If there is some return of muscle movement removal of vasoconstrictor tone will increase the blood supply which will then be maintained by the local vasodilator action of the muscle metabolites but where there is complete paralysis of the limb a sympathectomy is of little value

Raynaud phenomena.—The term Raynaud s Disease is generally applied to a miscellaneous group of conditions which exhibit phenomena more or less resembling the colour and temperature changes in the hands originally described by Maurice Raynaud in 1862 A review of investigation into some 800 cases of Raynaud phenomena has been given by Jepson.* In the group in which the phenomena are due to occlusive vascular disease there is considerable relief after sympathectomy particularly in those due to trauma emboli or cervical rib syndrome. There was also good response in patients suffering from arteriosclerosis or spontaneous digital gangrene a result surprising but true. Operation is in fact more valuable to the patient with this sort of state than it is in the average vaso-spastic of unknown etiology

The symptoms in the primary or idiopathic group sometimes cause so much distress that the patient is prepared to undergo operation in the hope of obtaining some mitigation of his suffering Although sympathectomy gives lasting relief in less than one-third of these cases there is so far nothing else to offer and Shumacher† considers the procedure worth while

There is rapid relapse after sympathectomy in secondary Raynaud phenomena due to scleroderma vibrating tool syndromes or collagen necrosis and also in Jepson s middle-age group consisting of middle-aged women in whom the phenomena began in the late thirties or early forties without any evidence of arteriosclerosis Operation is quite unjustified in these cases

Hypertension—There are many widely differing views on the etiology and treatment of hypertension and individual opinion of the rationale and use of sympathectomy for this condition varies accordingly The main hypotheses which have been advanced may be roughly grouped as neurogenic mechanical and humoral It is impossible here to make more than a cursory reference to these theories and the

* R. P. Jepson, *Postgrad. Med. Journ.*, 1953, xxix, 451
† H. B. Shumacher *Surgery* 1943, xiii, 1.

criticisms levelled against them the most serious of which is that, although they reveal the reason for an artificially produced rise of blood pressure in an experimental animal none gives a satisfactory explanation of the syndrome of hypertension as seen in the patient.

Neurogenic theories postulate sympathetic hyperactivity either of a generalized vasoconstrictor type or of the physiological pressor reflexes. *The mechanical theories suggest that hypertension is a response to* overcome arterial obstruction due to atheroma which is itself due to some disturbance in lipoid metabolism The well known pressor effect of adrenaline raises the possibility of over-activity of the adrenal medulla and this undoubtedly explains the hypertension secondary to phæochromocytoma. Another humoral theory which is currently popular is based on the experimental work of Goldblatt* who showed the release of a potentially pressor substance by the ischæmic kidney *An important fact which tends to be overlooked by supporters of this* hypothesis is that under the experimental conditions the blood pressure rises above normal in the arterial system as a whole but is below normal in the affected kidney From a critical survey of the original and succeeding papers it would appear that the work of Goldblatt has demonstrated the physiological mechanism by which the kidney is able to combat hypotension and maintain an adequate filtration pressure.

In the light of these varying theories therefore for sympathectomy to have any pretence to a logical basis it should open up large areas of the vascular bed interrupt secretory impulses to the adrenal medulla, and prevent vasoconstrictor impulses from reaching the kidney All these requirements are fulfilled by the Smithwick operation Even so Platt† considers sympathectomy to be an unphysiological procedure and in view of the tenuous nature of the hypotheses of the etiology of hypertension we must agree. On the other hand medical treatment has had little success so let us consider what sympathectomy has to offer the patient based on observed results.

From our own series of some 150 cases we find that sympathectomy results in little permanent effect on the blood pressure a significant reduction occurring in only 20 per cent and most of these cases were malignant hypertension in young women under the age of thirty Much greater success is obtained in those cases where only symptomatic relief is sought about 90 per cent. being relieved of headache and about 70 per cent. from eye symptoms Smithwick,‡ reviewing a series of nearly 1 000 cases has shown that in all groups the survival rate for the surgically treated patient was higher than for the medically treated patient Similar survival rates have been shown by d Abreu§ in a series of over 100 cases treated by sympathectomy The operative mortality in all these series was about 4 per cent

Hyperidrosis.—Primary hyperidrosis may be defined as excessive sweating of unknown etiology The palms are most commonly

* H. Goldblatt, *Physiol. Rev.*, 1947, xxvii, 120–65.
† R. Platt, *Proc. Roy Soc. Med.* 1948, xli, 330.
‡ R. H. Smithwick, *J. Amer. Med. Ass.*, 1951, cxlvii, 1611.
§ F. d'Abreu, *Lancet*, 1953, i, 1164

affected and the axillæ feet and face are involved to a lesser degree Physical stimuli such as exercise or heat produce normal thermo-regulatory sweating the outbursts of excessive sweating usually occurring only after some emotional disturbance or act requiring mental effort No local or general cause for the condition has been demonstrated.

The appropriate sympathectomy will abolish the outbursts of hyperidrosis in the affected part in addition to the thermo-regulatory sweating We have not seen any case in which there has been a recurrence after sympathectomy and we have not found any report of such a case in the literature It must be borne in mind that sympathectomy reduces the area of skin available for thermo-regulatory sweating and sympathectomy involving all four limbs may lead to exaggerated thermo regulatory sweating on the body which may be as much embarrassment to the patient as a mild hyperidrosis of the feet In the usual case where the hyperidrosis is mainly confined to the hands sympathectomy will result in removal of the symptoms and the complete satisfaction of the patient Such a patient may well ask for further operation to relieve a much less severe condition in the feet but considerable thought should be taken before acceding to his request

Angina pectoris.—In the selection of patients for sympathectomy or the relief of cardiac pain the surgeon must be guided by the cardiologist. The factors for consideration are the severity of the pain and the disability it causes the chances of successful relief and the operative risk to the patient Although there is no large series reported most surgeons employing this procedure are agreed that relief is obtained in a high percentage of cases Leriche and Fontaine* summarized all the cases reported at that date and found that relief was obtained in 70 per cent of cases after stellate ganglionectomy In our own experience extension to include the upper thoracic ganglia produces relief in almost all cases and we feel that this is by far the best method of obtaining relief of pain in a patient who is a reasonably good surgical risk.

Post traumatic painful states.—For reasons still not satisfactorily explained partial injury to a peripheral nerve is sometimes followed by the characteristic burning pain of causalgia. At the outset the skin of the affected part is hot red and hyperalgesic the patient obtains relief from cooling often wrapping the limb in a cloth soaked in cold water Later the hand or foot to which the pain is referred is cold cyanotic and sweating the discomfort is lessened by warmth Jarring or sudden movement of the affected part leads to paroxysms of intense agony In some patients these may also be brought on by other stimuli such as certain sounds light or emotional stress. Oddly enough the causalgia is much more common in battle injuries of the nerves than in civilian lesions

* R. Leriche and R. Fontaine, *Rapport, d'Assn. franc de chir* 1932, Paris.

The subjects of this exceedingly painful state are frequently regarded as psycho-neurotic but their rapid transformation after paravertebral novocaine block or sympathectomy strikingly proves the incorrectness of this judgment Novocaine block alone will cure some of these patients but the majority require a classical sympathectomy cervical or lumbar In true causalgia and in Sudek s atrophy the operation is almost invariably successful especially if undertaken early so much so that causalgia is ceasing to be a problem. In contrast sympathectomy is no use for painful neuromata whether in scars or amputation stumps

Of 48 cases of causalgia reported by R. Barnes all patients but three subjected to sympathectomy were benefited. Barnes found the results of pre-ganglionic better than post-ganglionic but the numbers are too few for strict comparison.*

R. Barnes. "Causalgia. M.R.C. Special Report, Series No. 282, Peripheral Nerve Injuries. London 1954.

CHAPTER XXXIX

GYNÆCOLOGICAL OPERATIONS

By JOHN HOWKINS

GYNÆCOLOGICAL operations are divided into (1) vaginal operations and (2) abdominal operations, sometimes both these routes are combined

Preparation of the patient. *Consent*—In any operation which may result in the removal of the reproductive potential of a woman it is advisable to explain the nature and scope of the proceeding In married women it is wise to obtain written consent Hysterectomy and sterilization should never be performed without such consent Operations which occlude the vagina and render intercourse impracticable should not be carried out without the full knowledge and consent of both husband and wife. In dealing with the nervous woman it is not always advisable to acquaint her with the full details of the case but the nearest responsible relative should be fully informed in her stead. If the patient is suffering from some form of cancer it is not the writer s practice to acquaint her of this fact but the husband or nearest relative must be fully informed

Operations during menstruation—Elective gynæcological operations are best avoided during menstruation as such patients bleed more readily at that time emergency procedures however, may be undertaken irrespective of the menstrual cycle

Secondary anæmia—Many patients suffer from excessive uterine hæmorrhage which may well render them anæmic and in these circumstances a careful inspection should always be undertaken and the condition of the patient s blood fully investigated. Blood grouping with a view to pre-operative and post-operative transfusion is a wise precaution and should always be done if the indicated surgical procedure is a severe one such as Wertheim s hysterectomy

Urinary tract—The urinary tract of these patients especially in cases of prolapse is frequently infected, and if the patient has urinary symptoms suggesting this a catheter specimen of urine should be collected examined and cultured, and any urinary infection treated before operation if possible This may save a post-operative urinary infection which is a not infrequent complication of gynæcological operations especially if catheterization is necessary In all gynæcological operations the bladder must be emptied the surgeon should catheterize the patient with a metal catheter in the theatre with the patient anæsthetized on the operating table Rubber catheters left in the urethra by the ward sister do not always empty the bladder and give a false sense of security they may become kinked and dislodged from their proper position and if they are removed and a

metal catheter passed—often when the bladder is said to be empty—a further few ounces of urine can almost always be obtained. An empty bladder is much less liable to be damaged than a partially filled one and this specially applies in the operation of total and vaginal hysterectomy A further advantage accrues from such a catheterization in that it provides the opportunity for a final sterilization of the vagina to be made with an antiseptic solution such as flavine or Bonney s blue or whatever preparation is in favour

Preparation of the bowels.—This is very important in gynæcological operations as an incompletely emptied rectum and colon embarrass the operation and the surgeon and may lead to post-operative bowel complications. For this reason it is advisable to admit gynæcological patients into hospital two days before operation and administer an aperient 36 hours and an enema at least 12 hours before the operation is performed.

Anæsthetic considerations.—Good anæsthesia with good relaxation is essential in most gynæcological operations. There are several reasons for this. The surgeon is operating at depth in a cramped space possibly in a fat woman and his difficulties should not be aggravated by the presence of the bowels trespassing into the operative precincts. Congestion and cyanosis increase bleeding and further embarrass dissection. The anæsthetist is fully aware of his requirements and it is not pertinent to say more than that difficult gynæcological operations should not be undertaken without the assistance of a competent anæsthetist versed in gynæcological technique Certain major procedures such as Wertheim s hysterectomy and Mayo s vaginal hysterectomy and repair difficult total hysterectomy and operations for endometriosis can be greatly facilitated by a spinal or epidural block if the surgeon is fortunate enough to have a colleague conversant with and experienced in its administration it gives a minimum of shock and bleeding with maximal relaxation Owing to the use of Trendelenburg s position and the embarrassment of the diaphragm by weight of the bowels lying upon it curare has certain drawbacks in gynæcological operations.

Preparation for a vaginal operation.—The external genitalia and a wide and adjacent area of skin should be shaved and the patient bathed once or twice. The vagina should be douched with an antiseptic solution such as Eusol and if there is much discharge this douching should be repeated as often as necessary A vagina which is prolapsed and ulcerated can most efficiently be cleaned by putting the patient to bed replacing the prolapse digitally and thoroughly douching the vagina which is then packed with gauze soaked in flavine and paraffin emulsion This procedure is repeated twice daily if necessary for several days. Such treatment reduces the infection and œdema of the prolapse to a considerable degree and makes subsequent operation safer and easier Iodine and picric acid are best avoided as in certain patients they give rise to a very unpleasant rash.

Preparation for an abdominal operation—The mons veneris vulva perineum and abdominal wall should always be shaved Elaborate pre-operative preparations are probably unnecessary and ineffective and shaving and two good baths are more efficacious than elaborate painting with antiseptics The surgeon can perform a quick skin sterilization with Cetavlon or iodine in the theatre.

Post-operative treatment *Immediate post-operative period*—When the patient is returned from the theatre she should be placed in a warm bed hot water bottles should be absolutely interdicted If the surgical procedure has been a severe one close watch should be kept for the onset of delayed shock and vaginal bleeding Certain operations such as difficult hysterectomies especially in anæmic patients are prone to produce shock and the surgeon and the anæsthetist will decide during or at the end of the operation whether such cases need plasma or blood. If the patient started with some degree of anæmia and has lost blood during the operation transfusions should not be stinted. Rectal salines are not particularly suitable for gynæcological cases and intravenous fluid is certainly more efficient. After most Wertheim hysterectomies if there has been considerable blood loss and the pulse rate is at all raised blood transfusion is a wise precaution

Catheterization—After vaginal operations involving dissection near the bladder and the urethra, and operations on the perineum there is some degree of difficulty in passing urine. In overcoming this there are two schools of thought. In one the surgeon passes a small self retaining catheter into the urethra as a routine on the assumption that though it is liable to cause urinary infection it is less liable to do so than multiple catheterizations by a series of different operators The other school favours intermittent catheterization as and when required. Whichever course is adopted however one point should be stressed—the bladder must not be allowed to become distended as this causes pain to the patient and certainly endangers the suture line in addition it encourages urinary infection and atony of the bladder If the vagina has been packed to control or obviate hæmorrhage a self retaining catheter must be left *in situ* Such a catheter should be withdrawn as soon as possible but may have to be reinserted if the patient cannot pass urine herself If the condition allows it should be withdrawn in 48 hours but can be left for as long as 10 days if absolutely necessary If left for a long period it is wise to irrigate the lumen at least once daily and to give appropriate urinary antiseptics such as sulphacetamide against *Bacillus coli* infection If a sulphonamide is employed it should always be administered with an alkaline diuretic and a glass of water the three being given simultaneously by the nurse This simple precaution will eliminate any risk of so-called sulpha kidney After Wertheim s hysterectomy and Mayo s vaginal hysterectomy and repair spontaneous micturition is unlikely and it is wise in these cases for the surgeon not to embarrass his patient s comfort but to leave in a self retaining catheter This will pay a

dividend in the long run and may be useful for washing out the bladder with small volumes of mild antiseptics The surgeon must keep a constant watch for urinary infection and be ready to have the urine bacteriologically examined should the clinical signs suggest *B coli* infection. If the bladder has been damaged during the course of the operation or severely traumatized so that a fistula might result, it is again a wise precaution to drain it continuously the best way to do this is by a self retaining catheter connected to a tube draining into a receptacle under the bed. The writer strongly deprecates the use of spigots in catheters The release of such spigots at intervals places an unnecessary strain on the nursing staff and serves no good purpose.

Flatulent distension of the colon —This is a common complication of abdominal operations such as hysterectomy hysterotomy and Cæsarean section. If this distension is allowed to persist unchecked a paralytic ileus may result which demands most vigorous treatment. During the late war it was found that small doses of morphine ¼ gr four hourly for the first 24 hours after operation was the best treatment for wounds involving the bowel and, contrary to our old belief opium in small doses does not favour flatulent distension. If the patient remains distended continuous duodenal suction is the best line of treatment as it allows the patient to drink and is the most efficient method of controlling severe post-operative vomiting For milder cases simple persuasive aperients such as emulsion of paraffin or Milpar in frequent doses started early are better than acetylcholine or Prostigmine though the use of this latter has an occasional place A flatus tube and a gentle colonic lavage with hypertonic saline solution or a glycerine enema will usually give just as good results as the more violent soap and water or turpentine enema which is highly irritant to the mucous membrane of the colon.

Posture —Patients after gynæcological operations should be allowed full freedom of the bed and to lie in any position which they fancy The routine use of Fowler s position has justifiably been severely criticized of late as has also the use of donkey pillows The great aim of the surgeon and his nursing staff should be to keep the patients moving about in bed. Some surgeons advocate post-operative physiotherapy such as massage and exercises and these undoubtedly do good but just as much can be achieved by encouraging the patient to move about voluntarily and freely herself. A patient is less likely to acquire pulmonary complications lying flat and moving from one side to the other with the foot of the bed slightly raised than she is in Fowler s position In most abdominal operations if the abdomen can be properly sewn up the patients can be allowed to sit with their feet over the edge of the bed in the first 24 hours and can be lifted out of bed and placed in a chair with advantage They should be allowed to walk about as soon as they wish It is by early movements and early ambulation that post-operative pulmonary complications and thrombophlebitis and phlebothrombosis can best be avoided.

Post-operative thrombosis and embolism —Hysterectomy hysterotomy Wertheim s hysterectomy and Cæsarean section are for some reason particularly liable to give rise to these complications It is believed that the clot arises in the deep veins of the muscles of the calf The earliest premonitory symptoms and signs are slight elevation of the temperature and pulse rates slight feeling of malaise and mild pain in the calf or thigh and hips. All such patients should be examined *several* times daily by the nursing staff and the surgeon for the onset of these signs and symptoms and if they appear heparin should be administered in adequate dosage It is the writer s practice to give an initial dose of 12 000–15 000 units of heparin intravenously which may be repeated 8 hourly for the first day Dindevan is given at the same time and its dosage controlled by daily prothrombin estimation. The patient need not be immobilized during this treatment If there is any sign that infarction of the lung has occurred the dosage can be increased Many cases of lung infarction are mis-diagnosed as atelectasis or post-operative bronchopneumonia and as such erroneously treated Early and repeated radiographic examination of the chest should be made as the clinical signs may be misleading

Care of the abdominal wound —Every surgeon has his own preference for the various sutures and clips and each will achieve good results with his own technique. The great aim is to avoid abdominal con striction with tight binders and these wounds are most suitably left without a dressing or covered with some suitable occlusive dressing kept in place with Whitehead s varnish or small strips of Elastoplast Perineal and vaginal wounds are usually sutured with catgut but some surgeons prefer to use nylon or silkworm gut in the perineum the latter stitches will have to be removed, usually about the seventh day and the vaginal and perineal wound should be douched with an antiseptic solution dried and powdered with an antiseptic powder after micturition and defæcation. Blood and discharge should not be allowed to collect in the vagina. If the vaginal wound becomes septic the installation of glycerine is efficacious. A dirty vaginal wound always improves when a patient can be made ambulant or put in a bath and this is usually possible about the fourteenth day If there is discharge it is a good plan to smear the vulval edges with petroleum jelly to prevent them adhering and interfering with drainage.

I. OPERATIONS ON THE VULVA

Urethral Caruncle

Urethral caruncles are best excised as cauterization is so frequently followed by recurrence. A metal catheter is passed into the urethra and held in position by the assistant The caruncle is held in fine-toothed forceps and drawn downwards. Three half-circular fine round bodied needles threaded with 00 chromicized catgut are then passed beneath the base of the caruncle from above downwards the

first being nearest the urethra. The point of the needle should enter and emerge through healthy mucous membrane. The needles are passed as far as the middle of their length and left *in situ* The base of the caruncle and a small area of healthy mucous membrane is then excised by cutting on to the needles After removal of the caruncle the needles are drawn through the healthy mucous membrane and the sutures tied. A small self retaining catheter is left *in situ* for a few days. Bleeding is minimal and it is not necessary to pack the vagina (Fig 896) The sutures absorb and do not require removal.

Removal of Bartholin Cyst or Abscess

An acute abscess of Bartholin s gland is best treated by incision and drainage. As this treatment is likely to be followed by recurrence of

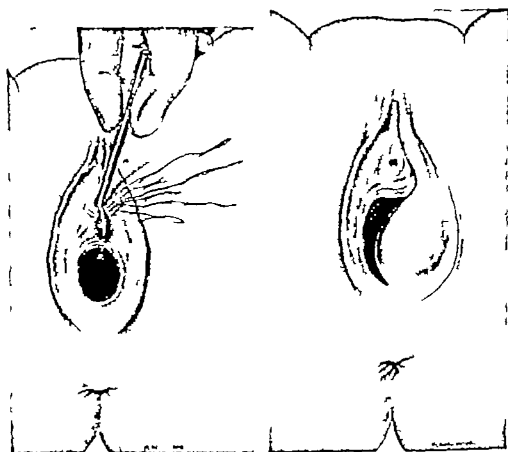


Fig. 896 —Urethral caruncle. Base transfixed with three needles these are left in position when the caruncle is excised on them.

Fig 897 —Bartholin s cyst. Note position of the incision lateral to the labium minus.

the abscess or the formation of a cyst the patient should be warned that the gland and its duct should be removed when the inflammatory process has settled down usually after three months

For removal of a Bartholin gland or cyst the patient is placed in the lithotomy position and an incision is made laterally through the skin at the side of the labium minus (Fig 897) The situation of this incision is important since if placed more medially it does not heal so readily and is likely to give rise to a painful scar with risk of subsequent dyspareunia The incision is made with a scalpel and the cyst is pressed outwards by the fingers of the left hand in the vagina so that it presents towards the incision All bleeding points should be secured with forceps the smaller vessels fulgurated with diathermy and the larger tied with fine catgut It should be remembered that this area is erectile and that oozing may be free The cyst is gradually freed from its bed by blunt and sharp dissection great care being used to preserve it unruptured In the base of the wound large vessels will be encountered and must be ligated to prevent recurrent bleeding Where the cyst is in contact with the vaginal wall on its inner aspect the mucous membrane is thinned and may be buttonholed. Care should be taken to avoid this and if it occurs the hole should be sutured with fine catgut If the cyst is ruptured great care must be taken to remove all the remnants of the lining membrane as the smallest remaining fragment may be a cause of recurrence Hæmostasis having been procured the cavity is firmly packed with gauze soaked in flavine and paraffin and one or two lightly tied silkworm gut or nylon sutures placed in the skin over this packing Free drainage to the exterior is essential. The vagina is then firmly packed with flavine and paraffin soaked gauze to exert good counter pressure on the inner wall of the cyst bed A self retaining catheter is left *in situ* Both packs are removed in 48 hours and a simple perineal dressing applied Attempts to obliterate the cavity by suture and to secure primary healing of the wound without drainage are liable to be followed by the formation of a large hæmatoma of the vulva which is painful and may take several weeks to resolve. If the technique described above is carefully followed the wound heals in about 14 days subsequent scarring is minimal and dyspareunia does not follow

Removal of Innocent Tumours from the Vulva

Sebaceous cysts fibromata, and papillomata may have to be removed. The principles to be observed are an incision so planned as to be clear of the growth hæmostasis and suturing without tension Every such tumour after removal must be submitted to histological examination by an expert pathologist

Simple Excision of Vulva for Leucoplakia and Intractable Pruritus

Two incisions are made as shown in Fig 898 The inner one starts in front of the urethral orifice and passes backwards just within the margin of the vaginal orifice. It crosses the middle line in front of the fourchette and runs forwards again just within the line of the

vulvo-vaginal margin to join the first part of the incision in front of the urethra The second or outer incision starts in front of the preputial folds of the clitoris and passes backwards along the outer border of the labium majus It crosses the perineum either just behind the fourchette or farther back according to the extent of the disease then turns forwards along the outer border of the other labium majus and joins the first part of the incision. All the cutaneous and subcutaneous tissues within the boundary lines of the two incisions are dissected off. Bleeding points should be picked up and tied.

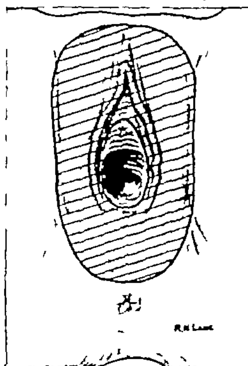


Fig. 898 —Excision of vulva for leucoplakia. The area illustrated for excision is larger than that quoted in the text and includes the region of the clitoris, as this is sometimes the site of pre cancerous lesions.

The first step in suturing this wound is to anchor the urethral orifice to the skin. A point is chosen on the left side of the patient where the skin will easily come in contact with the urethral orifice A suture is passed through the skin at this point and is then passed through the skin surrounding the urethra at its anterior margin. It is then passed through the skin of the right side of the wound and tied. The second suture is placed about ½ in posterior through the skin of the left flap and through the skin at the posterior edge of the urethral orifice and tied. A similar suture is passed on the right side. The two edges of skin anterior to the urethral orifice are then united by a series of interrupted sutures The skin of the rest of the wound has now to be united to the vaginal margin which is best done by a series of interrupted sutures they should be inserted alternately on the left and right side of the incision until the whole wound is closed.

Radical Excision of the Vulva for Epithelioma

When it was customary to carry out a limited operation for this condition without removal of the lymph nodes much less any attempt at systematic removal of the path of malignant invasion the results were very bad. Further growth on the opposite side of the vulva or local recurrence was frequent while invaded nodes continued to develop the neoplasm often extending beyond their capsules Radiotherapy was sometimes employed as an alternative to radical surgery but was often totally inadequate in its application with similarly disappointing

results. In any event many growths in this region turn out to be radio-resistant and with the best technique the results are uncertain. When the accepted surgical principles for the management of malignant disease were properly carried out without delay by those trained in cancer surgery the results were much better and in view of the very small mortality could be considered satisfactory

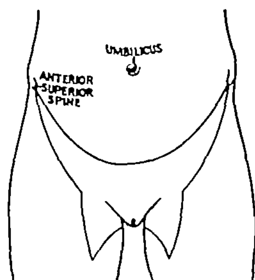


Fig. 899 —Radical operation for carcinoma of vulva. Skin incision. (*Figs 899–902 by kind permission of Stanley Way*)

To carry out these principles it was necessary to make a wide excision of the affected areas which in well-developed cases often meant the excision of the whole vulva. In all cases the nodes in both groins had to be removed by a well planned dissection carried as high as the anterior superior spine and for at least 3 in. above and below Poupart s ligament in order that the inguinal and femoral groups of nodes both superficial and deep could be completely eradicated Further the whole proceeding had to be carried out *en bloc* as a one-stage operation. However in view of the generally disappointing results which he has observed over a series of years Stanley Way has re-examined the whole problem and after careful and complete anatomical pathological and clinical investigation with a study of world literature has planned and carried out a very radical operation *

The aim of this operation is shortly defined as a one-stage resection of the vulva with block dissection of the lymphatic nodes on both sides as high as the bifurcation of the common iliac vessels. It is designed to remove widely the whole vulva so as to include not only the growth but the area in which premalignant conditions probably often exist All the lymph nodes in the groin and up to and including the external iliac nodes on both sides are to be removed together with ablation of the lymphatic anastomosis situated in the mons veneris. The whole proceeding is carried out *en bloc* and usually in one stage This plan of operating is now accepted by many gynæcological surgeons and may be said to be on an extended and extensive trial. The steps of the operation are described as follows.

Extradural anæsthesia with suitable premedication has usually been employed. The dissection of the groins is done first with the patient lying on the back. A semi-circular incision is made from one anterior superior spine to the other passing across the top of the mons veneris and a second from the anterior spine downwards towards Scarpa s

* Stanley Way (1948), *Ann Roy Coll. Surgeons Eng* iii, No. 4, 187

triangle and extended over the course of the saphenous vein. A return incision is then made upwards and medially towards the vulva from the lowest point (Fig 899) All the included skin and subcutaneous

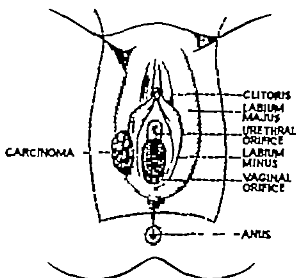


Fig 900—Plan of skin incision for removal of the vulva.

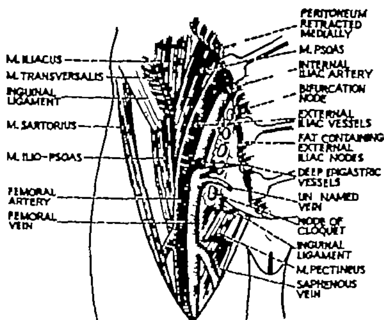


Fig 901—Showing access to external, bifurcation and, if necessary common iliac nodes by division of Poupart's ligament and section of transversalis muscle.

fat is demarcated for removal down to the depth of the external oblique fascia and inguinal ligament The great saphenous vein is defined and tributaries ligated and divided preserving the main trunk intact though this vessel can be sacrificed if involved.

The saphenous vein is followed up to the femoral vein which with that artery is exposed and cleaned of the cellular tissue All superficial inguinal lymph nodes are excised and the inguinal canal is then opened and the extra peritoneal portion of the round ligament removed. The subinguinal and deep femoral nodes are next defined The transversalis muscle and fascia are then incised at least 1 in above Poupart s ligament avoiding division of the deep circumflex iliac artery The muscle is incised for the length of the ligament and the anterior part of the iliac crest The peritoneum is now gently pushed away medially exposing the external iliac vessels. The deep epigastric vessels are

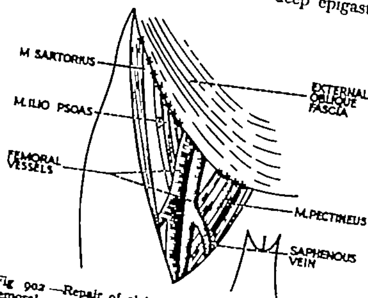


Fig 902 —Repair of abdominal wall and obliteration of femoral canal by suture of external oblique muscle to pectineus muscle.

divided ½ in. from the external iliac vessels A finger is passed from the femoral canal and the inguinal ligament divided and reflected outwards. The external iliac and femoral vessels are now clearly seen from the bifurcation of the common iliac to the apex of Scarpa s triangle The deep lymph nodes lying along the vessels including Cloquet s gland can next be removed in one piece It is important to remove the iliac nodes as high as the bifurcation of the common iliac vessels (Fig 901) Hæmorrhage is controlled by ligation diathermy and packing with oxycel The divided transversalis muscle and fascia and the external oblique are repaired by suture. The inguinal ligament need not be repaired but the femoral canal is obliterated by sewing the external oblique to the pectineus (Fig 902) The skin incision in the groin is closed by suture and the patient is then placed in the lithotomy position for the removal of the vulva with the tumour and any surrounding area of leucoplakia.

Using diathermy an incision is made down the inner aspect of the thigh to the ischio-rectal fossa and carried across to the other side in front of the anal canal. The vaginal wall is divided above the hymen

the urethral orifice is conserved (Fig 900) The mons veneris is now freed down to the periosteum of the symphysis pubis and the vulva and associated lymphatics removed If the growth is near the urethra the lower three-quarters of this canal should be removed. If the anal canal be involved this can also be excised and an inguinal colostomy established when the groin wound is healed. If the removal has been sufficiently thorough it is not possible to suture the vulval wound except in the perineal region the remainder being carefully packed with petroleum jelly gauze and left to heal by granulation with or without subsequent skin-grafting The insertion of a self retaining catheter is necessary to conduct the urine away from the raw area

This radical procedure may well give rise to post-operative shock, for which blood transfusion and intravenous fluid may be needed. A more serious risk because less under control is the fluid loss from the large raw area. This must be guarded against by continuous fluid administration and if necessary the free use of plasma. Some infection of the vulval wound is probably unavoidable and the resources of chemotherapy will be required Frequent sitz baths of saline solution are most helpful and comforting Lymphœdema of the lower limbs has been a fairly constant complication but it usually moderates or disappears in about 1½ to 2 years Very occasionally the condition may become chronic. Patients should be fully ambulant and encouraged to take exercise.

This is an extensive and serious operation and even in expert hands the primary mortality has been about 15 per cent. but it is suggested that the operation offers the best hope of ultimate cure in an otherwise particularly lethal disease In the series referred to in the Hunterian lecture by Mr Way the three-year survival rate was 88 per cent. and carried to the five year period the rate was 80 per cent. which is a remarkable record.

II OPERATIONS ON THE VAGINA

Enlargement of the Vaginal Orifice

The lithotomy position is employed two gloves are used on the left hand and the index finger is inserted into the anal canal and the perineum hooked forward. A midline incision is made from the posterior edge of the hymen to about an inch anteriorly of the anus and is deepened to divide all the superficial muscles of the perineum as far as the muscularis of the rectum and anal canal. The levatores ani are not interfered with. After withdrawing the finger from the rectum and removing the outer soiled glove the operator s left hand is immediately available for the second part of the operation which consists in stitching the vertical incision transversely Interrupted catgut sutures are employed every third stitch taking all the tissues to the bottom of the wound (Figs 908A and B)

HÆMATOCOLPOS

This condition due to congenital atresia hymenalis can usually be simply treated by incision of the bulging septum A word of warning must be given against performing this operation in the presence of hæmatometra and hæmatosalpinx because of the great danger of an intra peritoneal infection After incising a hæmatocolpos the

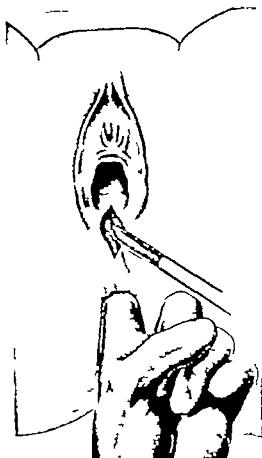


Fig. 903A.—Enlargement of the vaginal orifice showing incision through the perineal body as far as the muscularis of the rectum. Left forefinger in the rectum.

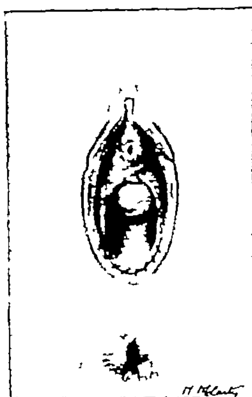


Fig 903B —The enlarged vaginal orifice sutured.

cervix should be examined while the patient is anæsthetized and if it is dilated hæmatometra must be suspected and bimanual examination of the Fallopian tubes must be undertaken to establish the presence or absence of hæmatosalpinx. In the presence of this condition opinion is sharply divided as to the correct procedure. Wilfred Shaw and Blair Bell favour bilateral salpingectomy and hysterectomy because of the danger of ascending peritonitis. This radical procedure is defended on the grounds that the tube is functionally useless. Te Linde Crossen, Eden and Lockyer and Curtis advocate more conservative treatment—namely excision of the hymen and drainage of the vagina by posture without irrigation the latter being considered

to encourage ascending infection The writer would favour conservative treatment provided that full prophylactic chemotherapy is employed

Removal of Cysts and Innocent Tumours

Cysts from embryonic remnants are sometimes found in the vagina. Solid tumours are extremely rare. In either case the operation for the removal of a simple tumour is carried out with the patient in the lithotomy position and an appropriate retractor is used to expose the cyst If the cyst is in the anterior or lateral wall an Auvard's speculum is satisfactory but if the cyst is in the posterior wall other retractors must be improvised to give exposure

The removal does not present any difficulty An incision is made over the tumour and it is dissected out by blunt dissection, bleeding points secured and the vaginal skin sutured with interrupted catgut sutures.

Atresia of the Vagina

Atresia of the vagina may be congenital or it may follow trauma in connection with childbirth or an operation. Great difficulty may be experienced in dealing with a stricture as there is very likely to be a considerable scar tissue which by cicatricial contraction has drawn branches from the internal pudic artery away from the side wall of the pelvis into such a position that they may cause very troublesome hæmorrhage when the scar tissue is incised

In favourable cases a longitudinal incision is made posteriorly and sutured transversely In unfavourable cases it may be impossible to obtain any improvement Such cases sometimes respond to prolonged treatment with graduated dilators

Congenital Absence or Obliteration of the Vagina

Several operations have been devised to make a new passage to replace the vagina in cases of congenital absence or to restore the canal when obliterated as the result of inflammation following injury or disease Hitherto the most successful method was Baldwin's which utilized an isolated portion of the small bowel Attempts to build a skin tube and to graft it into position attached by a pedicle have not been very successful These plans have now been superseded by McIndoe's operation which has yielded excellent results not only in the hands of the originator but those of many surgeons. The general scheme of this operation is to make a track from the perineum to the region where the cervix is normally situated and in the line of the normal vagina. This track is then lined by thin razor skin grafts implanted on a mould which is inserted into the track and kept in position until the period of scar contraction is over Thereafter the new vagina is to be kept patent by regular dilatation either by physiological processes or the use of dilators.

Technique.—The patient is placed in the lithotomy position the urethra identified and a bladder sound passed as a guide. The index finger of the left hand protected by two gloves is passed into the rectum and a vertical incision about 2 in long is made through

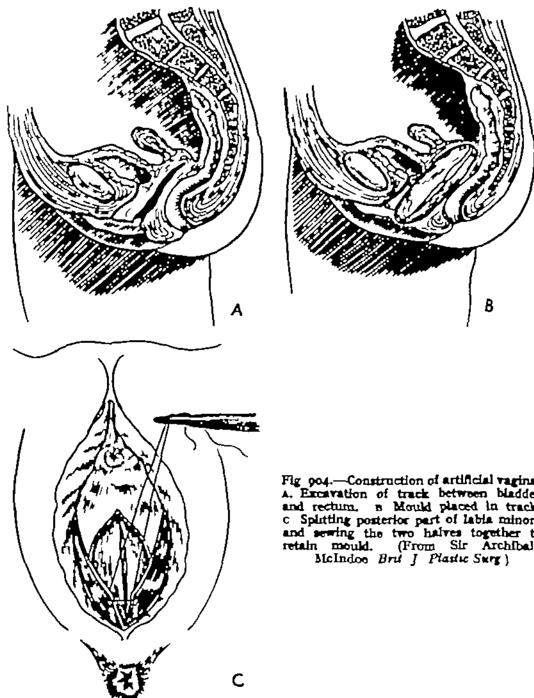


Fig 904.—Construction of artificial vagina. A. Excavation of track between bladder and rectum. B Mould placed in track. C Splitting posterior part of labia minora and sewing the two halves together to retain mould. (From Sir Archibald McIndoe *Brit J Plastic Surg*)

the skin of the perineum at the site of the normal vaginal orifice By a combination of sharp and blunt dissection with scissors and a finger a track is opened up between the bladder and rectum and dilated with two fingers. There is no great difficulty in finding a suitable plane of

cleavage here but the pubo-rectalis may need division between bladder and rectum. Any large vessels are carefully ligated and the cavity is temporarily packed with saline-soaked gauze wrung out dry in order to secure complete hæmostasis. A special mould made of acrylic plastic material measuring 5 in. long by 2¾ in. in diameter at its widest part is now fitted into the space excavated, in which it should lie quite snugly and completely enclosed (Fig. 904). It should fit firmly exerting even pressure all round. A Thiersch graft is cut from the thigh measuring 10 in. by 8 in. and this is spread over the mould with raw surface outwards and secured to it by Mastisol. It is important that the mould should be completely covered by the graft and it is best if this is in one piece and not buttonholed. The mould covered with the graft is inserted into the prepared cavity after removal of the gauze and final inspection to make sure that there is no bleeding. The mould is retained in position by splitting the posterior halves of the labia minora thus creating two raw surfaces which are carefully stitched together in layers across the fourchette. This makes a firm shelf across the vaginal orifice on which the lower end of the mould rests. It is important to leave a small hole at the top of this barrier to allow drainage from the grafted tunnel.

Post-operative treatment.—The bowels should be confined for five days; retention of urine may need to be treated by catheterization. Some discharge is to be expected from the wound area but this requires no special treatment except the wearing of sterile vulval pads. The patient may be up and about after three weeks. The mould must be left in position for six months. It may be necessary to enlarge the vaginal orifice when the mould is removed where the vulva has been sewn together. This is a very simple procedure and has already been described under Enlargement of the Vaginal Orifice. The bridge is divided by a longitudinal incision and is then sewn up transversely with a few interrupted stitches. The vagina, after removal of the mould, may present some few areas of exuberant granulation tissue where the graft has not taken. These areas should be treated by cauterization with silver nitrate and may need the application of small secondary grafts. To prevent stenosis after healing a No. 6 glass vaginal dilator should be worn for three months being kept in position by a T bandage. When healing is complete usually at the end of nine months or rather longer marriage is encouraged. Notable improvement in the vaginal epithelium takes place in a few months following regular intercourse. The results have been most encouraging with over 80 per cent of successes. When the uterus is normal pregnancy may occur in which event Cæsarean section is necessary for delivery.*

Readers are referred to the originator's Hunterian Lecture at the Royal College of Surgeons in 1941 and later publications.†

* Bonney and McIndoe, *Journ. Obst. Gyn. Brit. Emp.*, 1944, li, 4.
† McIndoe, *Brit. Journ. Plastic Surg.*, 1950, vol. ii, No. 4.

Anterior Colporrhaphy

The indication for this operation is the presence of anterior vaginal wall prolapse which may involve the urethra or the bladder or both If the urethra is prolapsed or the suburethral fascia deficient the patient will suffer from stress incontinence It is important to know if this symptom is present or not because the operative technique will need modification accordingly

The object of the operation of colporrhaphy is to excise such part of the vaginal wall as has become redundant and prolapsed and to free

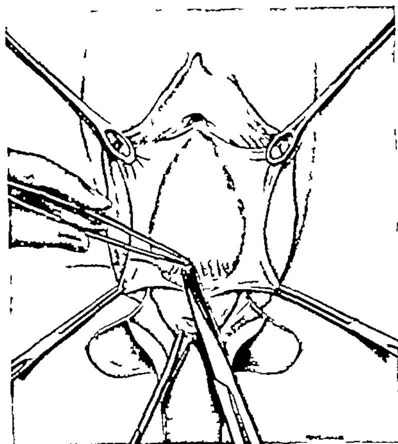


Fig 905.—Anterior colporrhaphy The cervico-vesical ligament is about to be cut after opening up the vesico-vaginal space.

thoroughly the bladder and possibly part of the urethra and sometimes the peritoneum of the vesico-uterine pouch from the surrounding fascial tissue so that these structures may be replaced upwards into their normal position. The fascial ligaments and tissue beneath the bladder must then be drawn together and repaired by suture and the operation completed by careful suture of the edges of the vaginal wall after the removal of the redundant part.

In cases of cystocele where there is marked stress incontinence it is usual first to carry out the standard anterior colporrhaphy with great care and thoroughness and to reserve the sling or other methods for a

second intervention in those cases in which the symptom persists or recurs In these persistent or intractable cases gynæcologists will either advocate the operation of retropubic urethro-vesicopexy after the technique of Everard Williams or Marshall, Marchetti and Krantz (*see also* Chapter XLIII) or some form of bladder neck support by a fascial sling after the technique of Aldridge or Millin and Read (*loc cit*) Details of the sling operation will be found on p 2155

Technique of anterior colporrhaphy—The patient is placed in the lithotomy position and the posterior vaginal wall retracted. The cervix is held with a volsellum forceps and an incision is made with

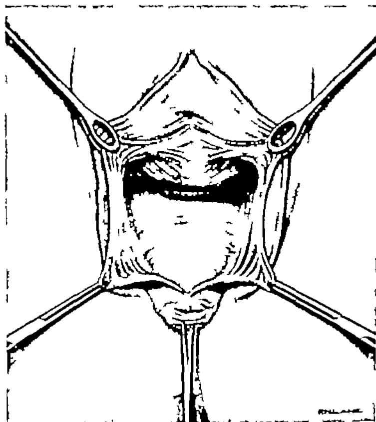


Fig. 906.—Anterior colporrhaphy The vesico-vaginal ligament has been cut and the bladder pushed up from the cervix. This is also an important step in the operation of vaginal hysterectomy

a scalpel from immediately below the urethra to the anterior lip of the cervix This incision divides the vaginal mucous membrane and opens the relatively bloodless vesico-vaginal space With toothed forceps the edges of the incision are retracted and a few strokes of sharp dissection separate the fascial retinacula from the vaginal flaps. The surgeon first works laterally separating the vagina and the thin vaginal fascia from the vesical fascia and the bladder When a sufficient distance has been achieved and this of course depends upon the extent

of the prolapse and the consequent redundance of vaginal wall the cervico-vesical ligament is divided after which the bladder can be pushed back from the cervix as far as is considered necessary The redundant vaginal wall in the lateral flaps is now excised (Figs 905 906)

Another plan is to outline an elliptical area for removal when the primary incisions in the vaginal wall are made Obvious bleeding vessels are caught and tied but oozing is controlled by the sutures and close approximation. A series of mattress sutures are placed from above downwards in the suburethral fascia and the vesical fascia which when tied effectively control the descent of the bladder and provide a good fascial support under the urethra. The vagina with its fascia is now united with interrupted sutures at intervals of half a centimetre It is better to employ interrupted sutures for two reasons (1) a continuous suture tends to shorten the anterior vaginal wall and (2) if it gives way at any point the whole suture line is in jeopardy The operation is completed by inserting a flavine and paraffin gauze pack into the vagina for 24 to 48 hours to control any oozing A small self retaining catheter is inserted into the bladder and left *in situ* This latter is very necessary because if the operation has been properly performed the patient is usually unable to pass urine for the first few post-operative days and retention sometimes lasts for 10 or even 14 days and need cause no alarm—in fact the reverse for it augurs a successful result so far as the stress incontinence is concerned.

Fothergill s Operation and Complete Colporrhaphy

Any operation which combines amputation of the cervix with anterior colporrhaphy is now loosely termed Fothergill s operation, but it should be noted that almost all cases of prolapse need a posterior colpoperineorrhaphy in addition to the anterior vaginal wall repair If this posterior part of the operation is not done the mechanism of the levatores ani will be inadequate

In Fothergill s operation the patient is placed in the lithotomy position, the posterior vaginal wall is retracted and the cervix drawn down with volsellum forceps. Marker forceps are applied at four points just below the urethral orifice one on each side of the cervix on the lateral vaginal vault about 1½ in from the external os though the greater the degree of prolapse the more lateral the position of these forceps and the fourth pair behind and above the cervix in the posterior fornix. The cervix is then well dilated The four pairs of forceps are now united by an incision which is roughly triangular with a convex base convexity downwards (Fig 907) The demarcated area of vaginal wall is dissected from above downwards from the vesical fascia. As the dissection proceeds the hypertrophied cervix is freed by cutting the cervico-vesical ligament and the bladder and ureters are gently thrust upwards out of harm s way by blunt dissection. The cervix is

now pulled to one side exposing the parametrium of Mackenrodt s ligament. A strong toothed clamp is placed on this ligament which is divided on the distal face of the clamp close to the cervix and the same manœuvre is employed on the other side. This clamp contains the descending cervical branch of the uterine artery. The cervix is then amputated as high as required. A transfixation suture is now

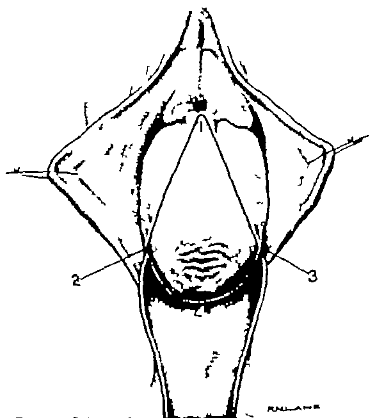


Fig 907 —Fothergill's operation. Showing Fothergill s points and the area of redundant mucosa to be excised with the cervix which is amputated.

passed through the cut Mackenrodt s ligament and securely tied. The next step in the operation is to insert Fothergill s suture. This enters the vaginal wall at Fothergill s lateral point takes a firm bite of the cut Mackenrodt s ligament and is then passed through the cervix above the point of amputation on the contralateral side of the midline from the bladder side to emerge through the dilated cervical canal. It then re-enters from the cervical canal passes through the cervix and out again on the bladder side across to the other cut Mackenrodt s ligament to emerge through the vaginal fascia at Fothergill s opposite lateral point (Fig 908A). When tied this suture anchors the cut

Mackenrodt's ligaments in front of the cervix at the same time shortening them. It thus provides a stout suspensory sling for the vaginal vault and incidentally tends to antevert the uterus. The bare posterior lip of the amputated cervix is now covered by passing a suture

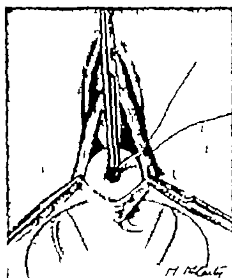


Fig. 908A.—Inserting the first suture.

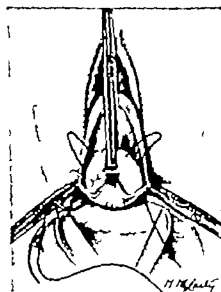


Fig. 908B.—The suture to bring the vaginal angles to the anterior part of the cervix.

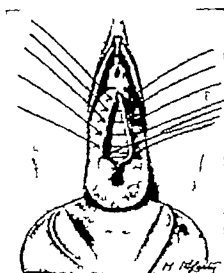


Fig. 908C.—The sutures in the anterior vaginal wall.

through Fothergill's posterior point in the mucous membrane and tying this leaving the two ends long (Fig. 908B). Each end is threaded on a needle and the needle is passed through the cervical canal to emerge half an inch higher up piercing the vaginal mucous membrane at two points ¼ in. from each other. When tied this suture pulls the

posterior vaginal flap snugly over the amputated cervix and reconstitutes the posterior part of the canal. The rest of the operation is completed as for anterior colporrhaphy described above (Fig 908c) Fothergill's operation should always be combined with a posterior colpoperineorrhaphy

Injury to the Bladder and Rectum

Injury to the bladder and rectum during vaginal operations should not occur if the surgeon proceeds by proper anatomical definition. If he should inadvertently have the misfortune to open the bladder the hole should be immediately sutured by two tiers of stitches and continuous catheterization instituted for 10 days. Most of these wounds if so treated by immediate repair heal without any anxiety or complication Injury to the rectum is most likely to occur when the perineum is grossly scarred by old obstetric trauma or previous operations for prolapse Sometimes an operation for fistula *in ano* is responsible for the scarring In these cases the surgeon should proceed with great caution until he reaches the recto-vaginal septum If at any time he is in doubt as to his anatomical bearings a finger should be introduced into the rectum and the dissection carried on against this as a guide. If he should make a hole in the bowel this must immediately be sewn in two layers and the case treated as for complete tear of the perineum As a rule only the muscular fibres of the rectum will be cut or damaged and it will be sufficient to repair this by sewing the muscle together with fine interrupted catgut sutures. Colostomy is quite unnecessary

Stress Incontinence

If stress incontinence is the main indication for the operative repair and if the case has not been operated on before for this symptom most gynæcologists will agree that the first line of treatment is a *purely vaginal operation.* This *operation, which may* be done alone or in combination with Fothergill's operation or vaginal hysterectomy *and repair or any other plastic vaginal operation for prolapse* comprises the following steps (1) A midline incision is made from the urethral orifice towards the cervix. The length of the incision depends on the degree of cystocele present (2) Two flaps of vaginal mucous membrane and vaginal fascia are now dissected laterally by blunt and sharp dissection until the urethra and bladder neck are exposed freely and widely If a cystocele is present the bladder itself is freed in addition It is important to emphasize that the bladder neck and urethra must be widely separated from the vaginal flaps. (3) When this dissection is complete it will be seen that there is a mass of muscular fascial tissue on either side of the urethra and it is this which must be brought together and sutured below the urethra and bladder neck. A needle threaded with No 3 chromic catgut is now passed into the lateral fascia so as to embrace it in a deep bite which must go down to the bone of the pubic ramus. It is usually necessary to pass

two or three stitches When these sutures are tied the bladder neck and the urethra must be pushed out of the way and upwards so that the urethra cannot be nipped by the sutures in which case a fistula may result (4) When these stitches are in place the redundant mucosa of the vagina is cut away the stitches are tied and the mucous membrane sutured together in the midline

After the performance of this operation the patient will have considerable difficulty in passing urine and will either need continuous drainage or catheterization three or four times a day (*vide supra*)

The percentage of cures to be obtained by the simple procedure outlined above varies with the skill of the surgeon and the strength of the fascia available In old thin asthenic subjects the urethral fascia is insufficient to hold the bladder neck in position and in those cases which have been previously operated upon the fascia may well be distorted and scarred to such a degree as to make the success of further repair unlikely It is therefore in elderly patients or in the recurrent cases that some additional measure of support will have to be considered.

The most generally adopted plan having extensive trial at the present time is some modification of the sling operation The basic principle underlying the many variations of this method is the support of the bladder neck by a strip of fascia or tendon taken from the external oblique fascia or the linea alba or even as a free strip from the thigh after the fashion of Gallie s operation for hernia.*

The next step is to pass the strip of fascia through the space of Retzius under the bladder neck in the vesico-vaginal space through which a tunnel has been previously opened. It is important to emphasize that the intervention will be useless unless the urethra, bladder neck and bladder have been well mobilized so that the sling supports the bladder neck in its normal position

Details of the Aldridge operation are briefly as follows Two oblique incisions are made as if the surgeon were going to repair an inguinal hernia. The incision is deepened to the fascia of the external oblique and a strip of fascia is cut from the tendinous part of the external oblique fascia and left attached by its base. The strip should be ½ in wide The vaginal part of the operation is now performed according to the technique already described for the vaginal repair of stress incontinence A tunnel is made by sharp and blunt dissection upwards and laterally through the triangular ligament 1 in from the symphysis pubis behind the descending ramus of the pubic bone into the space of Retzius. The fascial strips are brought down through this tunnel by means of long curved forceps and used as slings which are sutured in a criss-cross manner under the urethra and bladder neck. They are secured to each other and to the repaired urethra and vaginal fascia. The degree of tension employed must be nicely adjusted to give firm support without too tightly constricting the urethra The operation is completed by carefully closing the vaginal incision after

Aldridge, 1942 Studdiford, 1944 Millin, 1945 and Shaw 1949

excising redundant mucous membrane In the inguinal region the external oblique must be carefully repaired, the edges being over lapped if they are at all lax. The operation is completed by closing the skin incisions

Treatment of Vesico-Vaginal Fistula

Vaginal route.—The majority of fistulæ which are accessible can be repaired from the vagina, provided that there is no gross scarring and that the vaginal wall near the fistula can be mobilized from the subjacent structures. Previous unsuccessful attempts by this route with formation of scar tissue do not favour this approach but they certainly do not rule out the wisdom of a further attempt in more

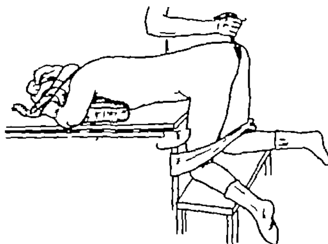


Fig. 909 —A modified knee chest position. Note that the lower abdomen is clear of the top of the table. (The drapings have been removed for greater clarity)
(After Chassar Moir Edin. Med. Journ.)

experienced hands. Those who have had the greatest experience (Marion Sims Gray Ward, Mahfouz Bey Chassar Moir) and have been the most successful would regard the vaginal operation as the standard procedure

Technique.—The position of the patient should be the reverse Trendelenburg with the patient prone and the legs over the end of the table Two assistants are required one to hold each leg with the thighs flexed on the trunk The patient may be in the kneeling position as shown in the diagram (Fig 909) and this position provides an excellent view The fistula being well visualized, a horseshoe-shaped incision with the base uppermost, is made round it through the anterior vaginal wall and this flap of vagina is reflected upwards The hole in the bladder is then exposed and mobilized by freely dissecting

back not only the vaginal flap but the edges of the vaginal wall When the bladder with the fistula is quite free scar tissue about its margins is excised and the aperture closed as necessity indicates Fine interrupted catgut sutures with a second tier of inverting sutures are best

OPERATIONS FOR URINARY FISTULA

Preliminary considerations.—It is important to ascertain the exact anatomy of the fistula before planning any operative repair This may demand a considerable urological investigation including cystoscopy the injection of dye* into the bladder passage of ureteric catheters intravenous pyelography etc. The state of the urine and the functional capacity of the kidneys must also be investigated

The elimination or amelioration of urinary infection is an essential first step in the treatment. The history of the case may be helpful if one or more previous attempts at vaginal repair have failed more radical methods may have to be employed. The only feasible method of treatment for the established vesico-vaginal fistula is by surgical operation but it is necessary to improve the general and local condition as much as possible before the intervention is undertaken Anæmia and infection both local and general especially demand attention

For the actual operation good exposure and illumination with complete relaxation are essential and the surgeon must not be embarrassed for the want of suitable instruments. Among the latter suitable needles and holders for passing sutures in awkward situations are especially important.

A very small fistula may sometimes be securely closed by the purse string method. The fistulous track in the vaginal flap is now resected the gap left in the flap is repaired, and it is sewn back in position in the vaginal wall. A rubber self retaining catheter is placed in the bladder to provide continuous drainage and is left *in situ* for 10 to 14 days until sound union can be expected. The lumen of the catheter must be kept clear by gentle irrigation twice daily and suitable urinary antiseptics are employed.

Upper or abdominal route.—This approach may be indicated if previous vaginal operations at the hands of experts have failed if the vagina is too narrow or if the position of the fistula renders the vaginal approach extremely difficult or nearly impossible. If the position of the fistula is near one or other ureter and there is danger of damaging this structure the abdominal route should be employed

Extra vesical approach—The abdomen is opened by a generous subumbilical midline incision employing Trendelenburg s position A transverse incision is made in the utero-vesical peritoneum and the bladder detached from the cervix and vagina in the same way as for a Wertheim s hysterectomy The bladder can be separated in this way from the vagina as far as its neck. The bladder and the vagina are

* For this purpose the dye must be very deep in colour Sterilised milk is easy to identify especially if coloured with methylene blue.

stitches have subsequently to be removed usually in 20 days Nylon (No 5) is also found useful rather than catgut which swells and sets up tissue reaction

Clots should be removed from the bladder at the conclusion of the operation and the indwelling catheter should be of the plain variety and not mushroom headed as the rim of the latter may come in contact with the inner aspect of the sutured fistula and cause pressure necrosis. When there is also a recto-vaginal fistula this should be repaired before the urinary fistula or at the same time to diminish the risk of infection

Ureteric Fistula

The ureter is liable to be injured in total Wertheim s and vaginal hysterectomies and even in the operation of anterior colporrhaphy It is also in peril during operations for broad ligament cyst or fibroid and in cases of endometriosis Injury usually occurs where it enters the ureteric canal in the broad ligament though sometimes it is damaged at a higher level The site of injury is important. If it is low it is not a difficult matter to mobilize sufficient ureter to make an implantation into the bladder without tension. For details of this operation the reader is referred to the relevant section of urology (*see* p 2298) If the site of the damage is too high for implantation into the bladder an attempt at repair by direct anastomosis may be made but this is usually disappointing and it is probably better to transplant the ureter into the colon straight away For details of this operation see the section of urology (*see* p 2301)

It cannot be too strongly emphasized that the most important thing about ureteric fistula is its prophylaxis. In any of the operations listed above in which the ureter may be in danger the gynæcologist should define this structure before blindly using scissors or applying a clamp or mass ligation in the danger zone (The reader is referred to the Presidential Address to the Section of Urology of the Royal Society of Medicine by Terence Millin Proceedings Vol. XLII p 87 1948)

III OPERATIONS ON THE PERINEUM

Perineorrhaphy

The cure of rectocele and repair of pelvic floor—The patient is placed in the lithotomy position the labia majora and minora are separated and the carunculæ myrtiformes defined They end on either side at points which appear to be about the middle of the lateral wall of the vagina. Critical examination will show that the whole of the posterior edge of the vaginal opening below these points is really epithelialized scar tissue and that the points when approximated, give the true normal vaginal orifice These points are seized with tissue forceps which are held by assistants who must be instructed

to hold them but not pull on them as the mucosa is very friable and easily torn It will be found that a ridge of scarred skin can be lifted up with the dissecting forceps between these two tissues forceps (Fig 911) and this ridge is cut off with the scissors or scalpel just sufficiently widely to remove the epithelialized scar tissue

The cut edge of the vagina thus exposed is picked up at its centre

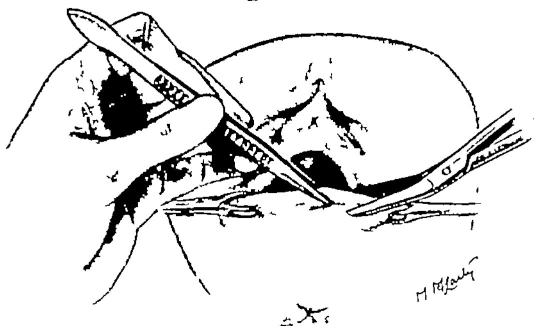


Fig. 911 —Cutting away ridge of scar tissue of perineum.

with dissecting forceps held in the left hand the third finger of which is inside the vagina and pressed on to the posterior vaginal wall to act as a guide A series of snips with the tip of a pair of round nosed scissors is made on to the tip of the third finger until the pearly white inner surface of the vaginal mucosa is exposed (Fig 912 p 2162) The dissecting forceps is then replaced by a Spencer Wells and it will be found that blunt dissection with the finger enters an avascular plane of cleavage just deep to the vaginal mucosa which can be carried up the posterior vaginal wall as far as required—to the cervix if necessary (Fig 912) The distance this dissection is carried is determined by the amount of the posterior wall to be removed in order that the reconstructed vagina may be a parallel cylindrical tube of a diameter that admits two fingers The finger is kept in this space and depressed to hold back the rectum The Spencer Wells on the centre of the vaginal mucosa is now drawn to one side and a semilunar fold of

connective tissue will be apparent on the opposite side. This fold is cut through close to the vaginal mucosa as far out as the tissue forceps on the carunculæ myrtiformes The Spencer Wells is drawn to the opposite side and a similar manœuvre performed

The finger is now withdrawn and the fingers of the left hand, which also holds the Spencer Wells are used to evert the posterior vaginal wall off which connective tissue is sponged with a swab The

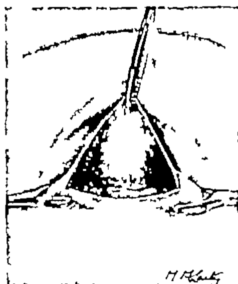


Fig 912 —Dissecting up posterior vaginal flap.



Fig. 913 —Cutting off posterior vaginal flap.

redundant portion of the vaginal wall is cut away with scissors (Fig 918) and care must be taken that sufficient is left to provide a parallel cylindrical tube after suture. At a point about an inch up the vaginal wall will be found incorporated with a firm band of tissue—the levator ani muscles – and especial care must be taken not to cut away too much vaginal mucosa here. Before severing the apex of this flap in the vaginal vault it is advisable to insert the highest suture as if the vaginal flap is cut off it may be difficult to find the central point. The cut edges of the vaginal mucosa are then united from above downwards with an interrupted catgut suture (Fig 914) and if the dissection has been accurately planned there is no dead space. As the suturing proceeds a point is reached where the levatores ani blend with the vaginal wall and the strong ridge of their edges is apparent. The end of this suture should now be drawn firmly upwards by the assistant This manœuvre will throw the levatores ani into still more prominent relief Two or three interrupted sutures should be put into the levator ani muscles bringing the edges of the two muscles together (Fig 915)

The vaginal suture is then continued to the tissue forceps on the

carunculæ myrtiformes When these forceps are reached they are removed and again the long end of the suture is pulled firmly upwards by the assistant The cut edges of the skin of the perineum may require trimming to obtain two even edges Immediately deep to these cut edges will be found the fascia covering the muscles of the



Fig. 914 —Inserting first suture before completely removing posterior vaginal flap.

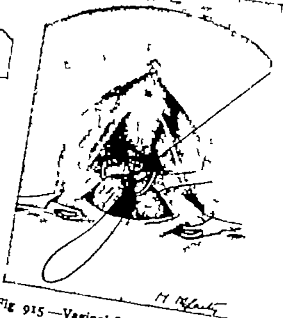


Fig 915 —Vaginal flap partly sutured needle picking up levator ani muscles

superficial perineal group and these muscles should be united by two or three interrupted sutures similar to those in the levator ani muscles. The skin of the perineum is united with interrupted sutures of catgut or nylon

For complete tear and recto-vaginal fistula —The same technique is carried out for both these conditions In a recto-vaginal fistula attempts to pare the edges and suture the margins often end in failure. Nevertheless with a moderate-sized fistula with but little scarring and a good perineum an attempt should be made at repair by direct suture For this to have a chance of success the vaginal wall must be freely separated from the rectum for at least half an inch all round the fistula. To enable this to be properly done a generous elliptical incision must be made through the vaginal wall surrounding the fistulous opening The vaginal edges are then dissected well back from scar tissue and from the rectal wall The edges of the hole in the rectum are then cleared of scar tissue and are thoroughly freshened and sutured together in two layers

The first layer should be of continuous catgut from above downwards This brings the edges of the hole in the rectum together and inverts them towards its lumen. The second layer is a series of interrupted stitches

passed Lembert fashion and burying the continuous suture The edges of the ellipse in the vaginal wall are then sutured together independently of the rectum and in such a way that they are turned towards the vagina. This is best done by a series of interrupted catgut stitches It should never be necessary to make a temporary

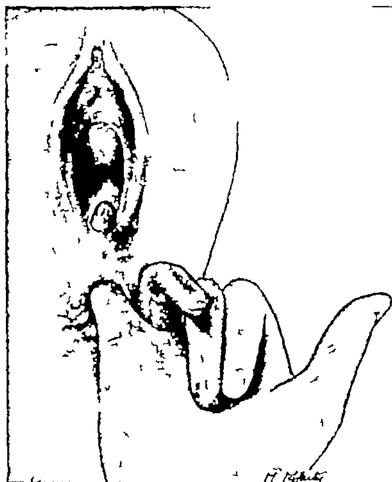


Fig 916.—Demonstrating recto-vaginal fistula.

colostomy The alternative is to divide the bridge of tissue between the anus and the fistula, converting the parts into the same state as in complete rupture of the perineum which is repaired as follows.

The operation begins in much the same way as that for repair of rectocele (Fig 916) The labia are separated (Fig 917) the carunculæ myrtiformes defined, and the last one on each side picked up with tissue forceps which are held apart The ridge thrown up in this case consists of vaginal mucosa united to rectal mucosa, and it is cut off as described above (Fig 918) The posterior vaginal wall is dissected up again but usually only for a very short distance as in most cases of complete tear there is no redundance. Having dissected and trimmed the posterior vaginal flap attention is next paid to the rectum and

anal canal Examination of the skin of the rectal margin will show that the rugæ instead of being arranged in a circle round the anal orifice are arranged as a fan posteriorly only and at each edge of the fan a dimple will be seen which represents the end of the torn retracted external sphincter This point is seized with dissecting forceps and drawn upwards and to the opposite side and a cut is made outwards and downwards through the skin and subjacent tissue as far out as

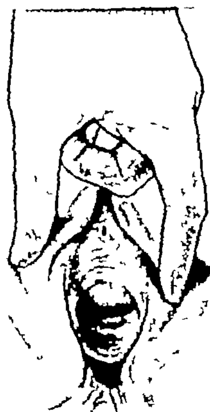


Fig 917 —Demonstrating complete tear of perineum.

the anal rugæ extend. A similar manœuvre is carried out on the opposite side The anal canal is freed from the levator ani muscles by gentle dissection with a swab assisted if necessary by a few snips with *scissors (Fig 919)* Interrupted sutures are inserted into the submucous coat of the anal canal carefully avoiding the lumen starting at the apex and continuing to the junction of mucosa and skin A second suture of the Lembert type is put into the internal anal sphincter this should completely cover the first suture line A couple of interrupted sutures taking a good bite are next inserted to join the torn ends of the external sphincter Sometimes this muscle is not apparent but it can always be found by inserting a suture fairly deeply in the apex of the postero-lateral cuts that were made to free

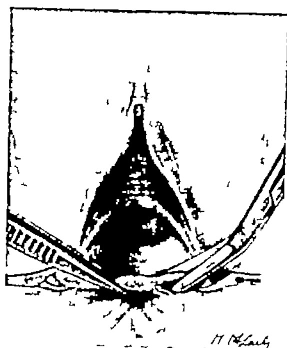


Fig 918 —Removing scar tissue between vagina and anus.

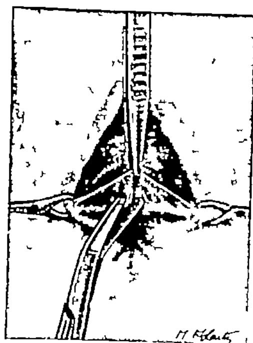


Fig 919 —Dissecting up posterior vaginal flap

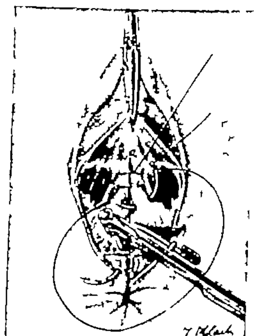


Fig 920 —The needle shows the suture in the rectal muscle tissue the Reverdin needle is shown picking up the external sphincter ani.

the anus (Fig 920) When these are tied they should cause the fan like arrangement of rugæ to become almost circular around the anal orifice

The operation is completed by suturing the vaginal mucosa, levator ani muscles and superficial perineal muscles in exactly the same manner as in perineorrhaphy for rectocele (*see* p 2160)

After-treatment —When the sphincter or rectal wall has been sutured it is important to keep the bowel quiet and to avoid purgatives.

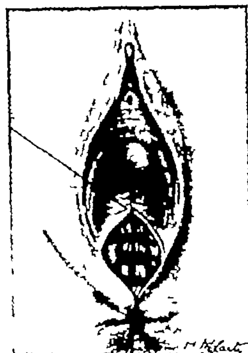


Fig. 921 —Levator ani suture suturing posterior vaginal wall.

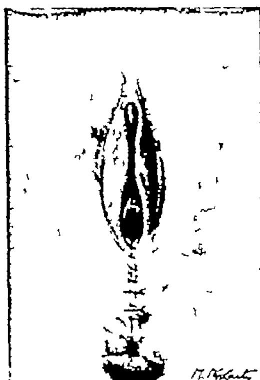


Fig 922 —Repair complete.

The patient may have ordinary diet in moderation and should take a teaspoonful of liquid paraffin thrice daily If there is much exalted peristalsis and trouble with wind 2 or 3 minims of tincture of opium will bring relief Should there be no movement of the bowel by the end of a week a glycerine enema (2 drachms) may start the process This method has the advantage that it can be repeated daily for a short time if necessary

IV OPERATIONS ON THE CERVIX

Dilatation of the Cervix and Curettage of the Uterus

The best and safest dilators to use are Fenton s double dilators and a word of warning should be given about their manipulation. The dilator is held rather like a pencil between the thumb and middle and

index fingers of the right hand the ulnar border of the right hand is steadied against the patient s left buttock and the dilator is passed from the wrist only so that its passage can be controlled throughout and any sudden forward movement checked. In this way undue force is not used and perforation is therefore less likely

The indications for the operation are (*a*) diagnostic to secure histological specimens of the endometrium polypi etc. and (*b*) therapeutic in cases of dysmenorrhœa and sterility and for the removal of myomatous polypi or pieces of retained placenta. Dilatation of the cervix is also carried out in most operations on the cervix such as amputation and Fothergill s operation and to drain a pyometra or hæmatometra. It is also employed before the insertion of radium.

Operative technique.—After routine cleansing of the vulva and vagina the posterior vaginal wall is well retracted by a speculum and the cervix grasped by one or two volsellum forceps. A uterine sound is passed to ascertain the length and direction of the canal Sometimes the external os is stenosed by trauma, inflammation operation or radium and it may be difficult to find the canal or the latter may be too small to admit the ordinary uterine sound, in which case a small, malleable probe will be necessary With care and patience the canal can almost always be found. A careful bimanual examination should always be made before the passage of any instrument and this will give the surgeon an idea of the length and direction which the sound can safely travel. During the process of dilatation the volsellum forceps holding the cervix are grasped in the operator s left hand and the process of dilatation can be helped by drawing the cervix over the dilator with the left hand. Dilatation must be slow and steady and there should be no tearing It may take from 15 to 20 minutes to dilate a very rigid cervix. The amount of dilatation employed will depend upon the indication for the operation for a diagnostic curettage in sterility or for dilatation for dysmenorrhœa, a No 9 Fenton dilator will be found sufficiently large if digital exploration of the uterine cavity is indicated or the removal of a small submucous myoma is contemplated, the cervix can be dilated with instruments up to No 18 or No 20 (Fenton) Some surgeons when dilating for dysmenorrhœa leave a small glass stem pessary in the cervix for 24 hours. The writer does not consider that this achieves anything more than ordinary dilatation and many patients will find the presence of a glass stem pessary painful. It is not necessary for the patient to stay in bed for more than three or four days after a straightforward dilatation.

Dangers of the operation. *False passage*—Sometimes the point of the sound or dilator impinges upon a mucosal fold in other cases acute ante-flexion or retro-flexion may make the passage of the instrument round the angulated corner very difficult. If undue force is used in these cases a false passage may result. Some cervices are either so spastic or so rigid that dilatation is difficult and in these cases it is essential not to hurry the process but to allow each dilator to

rest in the canal long enough to overcome the spasm or rigidity before passing the next size

Laceration of the cervix —The use of undue force too much speed or too large a dilator can cause laceration and rupture of the cervix If a rupture occurs quite considerable hæmorrhage may result and in rare cases a branch of the uterine artery may be torn The writer can remember a case in which this occurred and a large broad ligament

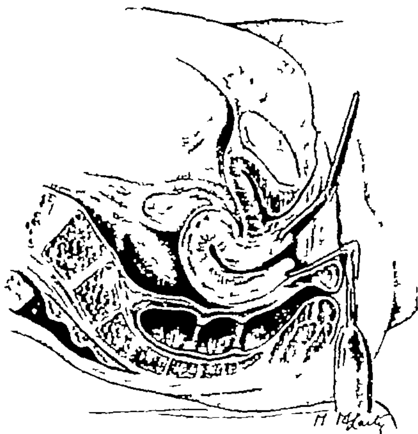


Fig. 923 —Sagittal section of the pelvic organs.

hæmatoma resulted necessitating abdominal exploration. A large tumour appeared above Poupart s ligament four hours after the dilatation of the cervix and was associated with considerable shock. The patient required transfusion

Perforation of the uterus —This can occur into the peritoneal cavity into the broad ligament, or through the anterior wall posterior to the bladder intra peritoneally or extra peritoneally It is particularly liable to happen if the uterus is unduly softened as in carcinoma of the body of the uterus and in pregnancy It is a common accident in criminal abortion Perforation of the uterus should be suspected if the passage of the sound or dilator exceeds the expected maximum as assessed by bimanual uterine examination Almost all gynæcologists of experience must admit that they have perforated the

uterus at some time and in clean cases the accident is not a very severe one. If the accident is recognized immediately and the case is free from infection it is sufficient to keep the patient under close observation with a quarter hourly pulse recording and to give prophylactic chemotherapy If however the case is one in which malignancy is proved or suspected or sepsis apparent or potential or the tear in the uterus is of sufficient size as to allow prolapse of a piece of small bowel or finally if an intra uterine douche has been employed then the abdomen must be opened forthwith If the condition is one of malignancy of the body of the uterus panhysterectomy will be performed. If the case is septic hysterectomy may be indicated but not always but drainage of the abdominal cavity is probably a wise precaution in these cases If the bowel has prolapsed through the rent it must be inspected for damage which if found must be repaired according to the injury If a douching fluid has been injected into the peritoneal cavity this must be swabbed out and again it is wise to provide drainage. In young women the rent can be closed by simple suture and the omentum drawn over the site of the tear Another indication for exploration after perforation of the uterus is the presence of the symptoms and signs of internal hæmorrhage and in these cases the abdomen will be opened some hours after the original accident. Peritonitis may occur after perforation Such cases are best treated conservatively in the first instance with full doses of chemotherapy and if necessary intravenous fluid. If the case does not respond to this conservative treatment as shown by deterioration of the patient s condition—a rise in pulse rate or the signs of septic intoxication—it will be necessary to open the abdomen and provide free drainage possibly through each iliac fossa through Douglas s pouch into the posterior fornix and the lower end of the abdominal incision. Perforation into the broad ligament has already been mentioned and this may give rise to an extensive retro-peritoneal hæmatoma. In the case mentioned above a hysterectomy was necessary to control the bleeding-point with drainage to the retro-peritoneal space.

Infection—Salpingitis pelvic peritonitis or pelvic cellulitis sometimes occur following dilatation of the cervix and this is a special risk if the case is a septic one For this reason dilatation should always be avoided in the infected case and should be postponed until such time as the infection has been controlled.

A sharp curette is passed through the cervix to the fundus and with a series of strokes from fundus to cervix an endeavour is made to remove the entire endometrium. The curettage should commence anteriorly and the surgeon should go round the cavity of the uterus clockwise. To avoid perforation during the actual curettage in the recently pregnant uterus it is best to use a blunt curette. If hæmorrhage is brisk from the uterus after curettage it is sometimes necessary to pack the uterus lightly but firmly with a thin roll of gauze soaked in flavine and paraffin emulsion This should be removed in 12 to 24 hours. When there is the slightest question as to the nature of the

condition demanding the curettage the fragments removed should be examined histologically by a competent pathologist After curetting for any cause it is often advisable to swab the uterine cavity with an antiseptic such as flavine or violet green solution The after-care will depend a good deal on the indication for the curettage four to seven days will suffice for most cases.

Insufflation of the Fallopian Tubes

To determine the patency of the Fallopian tubes after dilating the cervix the last graduated dilator passed is hollow and is connected up to some form of tubal insufflator Most of these machines operate by a small electric motor which drives a recording drum on which a permanent record of tubal behaviour is obtained. These machines allow a small volume of CO_2 controlled by a manual valve to pass into the cannula and the pressure and volume of the gas can be varied by the operator CO_2 is delivered from a small sparklet container If any CO_2 enters a vein it is readily absorbed and the risk of embolism is minimal. Atmospheric air should never be used for this reason If the tubes are normally patent the gas passes through at a pressure of about 60 mm Hg In some cases no gas passes until a pressure of 200 mm. Hg is reached if so this pressure should be sustained for about a minute. If still no gas passes the tubes are usually blocked but in some cases after an interval the pressure drops and gas thereafter continues to pass through the tubes at a much lower pressure The probable explanation is either that the tubes are spastic or more rarely that light filmy adhesions of the abdominal ostium have been broken down so that the tubes previously partially blocked have been made patent

Dangers of insufflation.—No woman with an obviously infected vagina or cervix should be submitted to the operation of insufflation of the Fallopian tubes until such infection has been eliminated nor should any woman who has obviously gross pelvic sepsis clinically demonstrable be insufflated In such cases there is a small but real danger of lighting up a salpingitis or pelvic peritonitis Insufflation should never be performed except immediately after menstruation.

Vaginal Myomectomy

Though this is never to be regarded as an ideal operation it may be expedient and life saving in feeble old women very ill as the result of blood loss or suffering from some constitutional disease. The one indication for the route is a dilated cervix and an easily accessible tumour A polypoid fibroid which can be felt by the finger inserted through the dilated cervix is seized by volsellum or ovum forceps and twisted out of its bed. The twisting will occlude the blood vessels and stop all bleeding Larger usually sessile fibroids may be removed in favourable circumstances by enucleation or morcellement For this last method the cervix should be dilated to the fullest extent. The

nearest part of the fibroid is seized with volsellum forceps and with a pair of scissors as much of the fibroid as can be reached is cut away The manœuvre is repeated again and again until all the fibroid has been removed If hæmorrhage is troublesome it may be readily controlled by packing the cavity of the uterus and securing firm contraction of the organ by the appropriate drug A definite risk of this operation presents as partial inversion of the fundus and towards the end of the morcellement it may be found that the uterus has been cut right through and the peritoneal cavity opened It is therefore unwise to tackle any but the smaller accessible fibroids by this route.

Trachelorrhaphy

Deep tears of the cervix are sometimes best treated by a plastic operation The cervix must be exposed grasped and steadied by volsellum forceps Graduated dilators are now passed up to No 12 Hegar The cervix is drawn to the opposite side to bring the laceration as much into view as possible A V-shaped incision is made with a scalpel on the vaginal portion just clearing the edges of the laceration and taking especial care that the apex of the V quite clears the apex of the laceration This incision is carried deeply into the substance of the cervix, in order to expose the fibro-muscular portion clearly and definitely An incision is now made on the endo-cervical aspect of each lip of the laceration deeply into the cervix to meet the first incision to remove a V shaped portion of tissue. Starting at the apex sutures are then inserted with a well-curved bayonet pointed needle. They must be taken fairly widely—i.e. about one-quarter of an inch from the cut edge—on the vaginal surface and must pass deeply through the tissue of the cervix to emerge just under the cervical mucosa. The needle is then passed through the other side in exactly the reverse direction so as to emerge on the vaginal portion one quarter of an inch from the cut edge A series of sutures is passed. The one at the apex is tied first and the others in order downwards *The operation is thus completed and the cervix restored to* its normal appearance

Amputation of the Cervix

This operation is best done by the method originally described by Victor Bonney but often known as Sturmdorf's operation. The cervix is exposed by inserting Auvard s speculum and is seized and steadied by volsellum forceps. It is advisable to dilate the cervix to the extent of No 12 Hegar A horseshoe-shaped flap with the convexity downwards is marked out with a scalpel on the anterior surface of the cervix and the mucous membrane is dissected up until as much of the cervix as it is proposed to remove is exposed (Fig 924) A similar flap is then marked out and dissected up on the posterior wall of the cervix. The descending cervical branches of the uterine artery will be lying in the connective tissue on each side at the angles where these two flaps meet These vessels should be ligated, by passing a

suture deep to them with a fully curved needle at either side and tying superficially to the connective tissue containing the vessels afterwards cutting the tissue and vessels below the tied sutures The cervix is then cut across with a scalpel. As the anterior part is severed it is as well to seize the stump with another volsellum forceps as it is apt to retract and be difficult to secure again. Having seized it the amputation is completed.



Fig. 924.—Defining the flaps.

The next stage of the operation is to suture the flaps over the stump The suture is passed through the edge of the anterior flap and loosely tied leaving both ends long Each end is then passed on a needle through the cervical canal and amputated cervix to emerge through the vaginal mucosa about three-quarters of an inch above the amputation level in the mucous membrane (Fig 925) Each of these sutures should be so passed that it comes out about one-quarter of an inch from the midline When pulled tight and tied, it will be found to turn the flap into the lumen of the cervical canal and cover the anterior half of the stump The posterior flap is dealt with similarly and the sutures are used as tractors in place of the

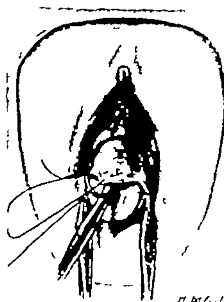


Fig 925 —The suture turning anterior flap into the cervical canal.



Fig 926 —Appearance of cervix when amputation has been completed.

volsellum forceps. Two or more small sutures are necessary on either side to approximate the rest of the edges of the two flaps (Fig 927)

Removal of Cervical Stump

It is sometimes necessary to remove the stump of the cervix which has been left at a previous subtotal hysterectomy The patient is placed in the lithotomy position and an Auvard s speculum inserted. The cervix is seized with volsellum forceps and drawn down as far as possible. The vaginal mucous membrane on the anterior surface of the stump is picked up by dissecting forceps and incised. By very careful blunt dissection the stump is freed from the bladder Great care must be taken as the bladder is densely adherent to the stump and if this viscus is injured, a vesico-vaginal fistula will result and will be very difficult to close. An assistant next holds the volsellum forceps towards the symphysis pubis to expose to the operator s view the posterior aspect of the stump and by a similar manœuvre the mucous membrane is picked up and incised and by blunt dissection the peritoneum of the pouch of Douglas is separated until the finger reaches the anterior dissection and can be hooked right over the stump The stump is then drawn to one side and the anterior incision in the vaginal mucosa joined by a lateral incision to the posterior incision, and the vaginal flap pushed upwards with a swab A similar manœuvre is carried out on the opposite side. The first finger is then hooked right over the cervix, the cervix drawn to one side and the tissue lateral to it containing the cervical branches of the uterine artery is seized with artery forceps and divided on the cervix side of the forceps This manœuvre is repeated on the opposite side and the cervix removed. If the abdominal cavity has been opened the peritoneum should be sutured to close the opening The tissue in the artery forceps should be transfixed with a catgut ligature and tied and the two lateral stumps united to act as a support for the vault of the vagina. The cut edges of the vaginal flaps are then sutured with interrupted sutures of catgut.

V OPERATIONS ON THE UTERUS

Hysterectomy

There are four main types of hysterectomy subtotal total, Wertheim s and vaginal hysterectomy *Subtotal hysterectomy* though described in the text is an obsolescent if not obsolete operation and its performance can only be justified when the operator feels that the total operation would endanger the life of his patient In the hands of a competent pelvic surgeon this justification hardly ever arises. The occasional and the less experienced gynæcologist may however be better advised to perform a subtotal hysterectomy than to inflict severe damage upon the bladder or ureter and for this reason the operation is described below

The reasons that have caused modern gynæcologists to abandon the subtotal operation are as follows —

1 The cervical stump may be or may later become diseased by chronic inflammation such as cervicitis or erosion which will cause discharge and demand treatment

2. Polypi may develop in the stump and need removal or amputation of the cervix

3 There is a small but real risk of carcinoma developing in the stump If this occurs the treatment is difficult and the prognosis poor

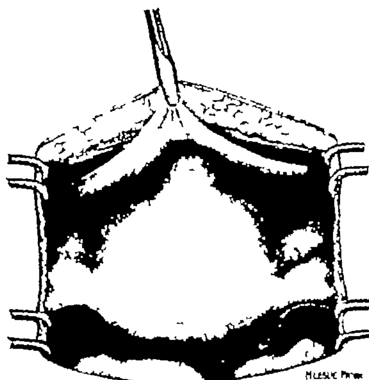


Fig 927 —Laparotomy uterus containing fibroids.

Wertheim s hysterectomy is only performed for carcinoma of the cervix *Vaginal hysterectomy* is particularly indicated for prolapse in a woman between forty and fifty who is also suffering from excessive loss at the periods and the operation which will be described to illustrate this operation will be the combined vaginal hysterectomy and plastic repair of prolapse Many gynæcologists are of the opinion that vaginal hysterectomy and repair is the operation of choice for all cases of procidentia at or after the menopause

Abdominal hysterectomy—The patient is catheterized on the table by the surgeon The incision of choice is a midline incision below the umbilicus or a low paramedian incision

Subtotal hysterectomy—When this operation is being performed for fibroids the incision should be just large enough to allow the operator to deliver the tumours (Fig 927) The upper border of the

broad ligament should be gently grasped between the thumb and first finger and the ovarian vessels Fallopian tube and round ligaments defined and clamped with two pressure forceps so that these structures can be divided without bleeding (Fig 928) Longitudinally ground forceps are safest (McCullagh s Heneage Ogilvie s or Howkins pattern) as these prevent vessels from eluding the bite at the apex in a large pedicle A similar manœuvre is then carried out on the opposite side. The uterus can then be lifted farther out of the wound and the *reflection of peritoneum on to the surface of the bladder defined in*

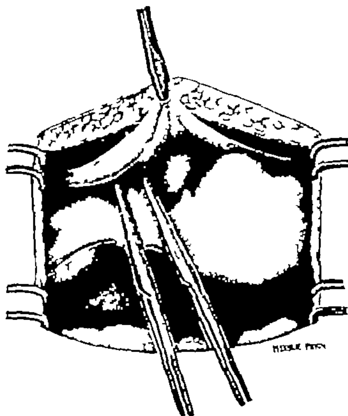


Fig 928 —Clamping the left broad ligament.

the utero-vesical pouch If the forefinger is inserted between the layers of the broad ligament where it has been cut it will enter a very loose connective tissue plane where the peritoneum is loosely attached to the front of the lower uterine segment just above the bladder (Fig 929) The finger can easily be worked through this loose connective tissue plane to the opposite side and the peritoneum is then cut from the uterus using the finger to guard the bladder from injury The bladder is pushed off the cervix just sufficiently to be clear of the point where the cervix is to be cut across. The forceps on the uterine cornua are used as tractors and the uterus is drawn to one side and an artery forceps placed on the uterine artery just where it is ascending the cervix slightly higher than the level of amputation. The vessels

are cut with a scalpel and the manœuvre repeated on the opposite side. The cervix is cut straight across with a scalpel completing the removal of the uterus. The stump is then grasped in a volsellum forceps to prevent its downward retraction

The next step is to ligate the main vessels and in each case it is advisable to ligate with a transfixion suture and a surrounding ligature The forceps holding the left ovarian vessels should be taken first and a needle passed through the round ligament. It is tied round the ovarian vessels before the forceps is released and then the same ligature is used to surround the ovarian vessels and round ligament (Fig 930) The left uterine vessels should next be dealt with a needle being passed just through the edge of the cervix immediately below the point of the

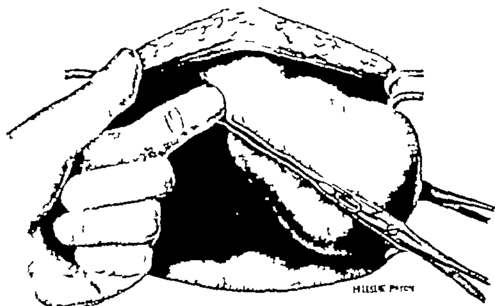


Fig 929 —Separating the reflection of peritoneum on anterior surface of uterus.

forceps holding the uterine artery A mass ligature is then tied including all the tissues grasped by the forceps in the base of the broad ligament. As this ligature is tied the forceps should be released and the uterine vessels seized again separately and the ends of the ligature can then be used to make a second ligature around the vessels separately These manœuvres are repeated for the right uterine and right ovarian pedicle respectively In most cases especially if care has been taken in inserting the needle for the ligation of the uterine arteries the stump of the cervix will be quite dry but occasionally there may be one or two bleeding points The best way to control them is to put two or three sutures of stout (No 8) catgut into the stump which when tied, will completely control any bleeding To insert these sutures the needle should be a cutting pattern (Mayo s trocar point) and should be passed through the substance of the anterior part of the stump from before backwards and then through the posterior part of the stump coming out through the peritoneal

covering posterior to the cervix An additional advantage of this suture is that it rolls the raw surfaces of the stump inwards on to itself as well as being hæmostatic.

The pelvic peritoneum may be closed in one of two ways and the length and mobility of the ovarian pedicles indicate which method to use If they are sufficiently long and mobile easily to reach the stump of the cervix without tension a purse-string suture round each half of the pelvic peritoneum will effectively bury all the raw ends of the pedicle and will at the same time fix the ovarian vessels and round

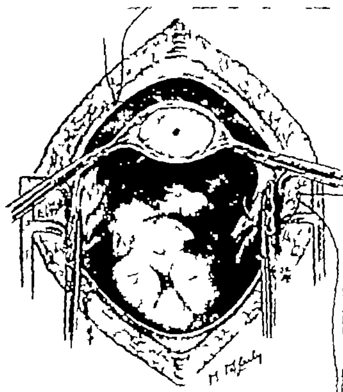


Fig. 930 —The pelvis after subtotal hysterectomy showing the position of sutures in ovarian pedicle and round uterine artery

ligaments on to the stump of the cervix so affording a measure of support to the pelvic floor To insert this suture begin at the middle line of the posterior cervical peritoneum and taking stitches at about half inch intervals as near the free edge as is convenient pass the suture outwards along the posterior leaf of the broad ligament and through the peritoneum covering the ovarian vessels then transfix the round ligaments and end by taking two or three bites of the vesical peritoneal flap Care must be taken to avoid puncturing the ovarian and uterine vessels This suture is tied and a similar procedure used for the other side. The result of this suture is a very

complete covering in of all the raw area and also the smallest possible intra peritoneal scar with correspondingly low risks of subsequent adhesions

In some cases the ovarian pedicle is short or insufficiently mobile to reach the cervix specially if it has been necessary to remove the ovary In this case the peritoneum should be repaired to cover any raw area on the pelvic floor with a continuous suture from side to side. Starting just mesial to the left ovarian pedicle the suture is passed through the edge of the anterior layer of peritoneum just through the edge of the ovarian pedicle and then through the posterior peritoneal flap and tied. The needle is then passed successively through the edges of the anterior and posterior flaps from left to right and the right ovarian pedicle buried in a similar manner to the left

The operation is completed by suturing the abdominal wall in layers Great care is needed in suturing a midline incision to ensure the least risk of scar hernia. The transversalis fascia should not be neglected above the semilunar fold of Douglas. For the anterior rectus sheath interrupted sutures should be employed or better still No 35 or No 36 gauge stainless steel wire. This is an excellent suture material but it must never be allowed to kink or it will break It is non irritant to the tissues and in the writer s opinion gives the best and strongest scar and the one that heals almost always by first intention

Total hysterectomy —The bladder must be completely emptied for this operation which is started in an exactly similar manner to subtotal hysterectomy as far as separating the bladder but in a total hysterectomy this dissection must be carried out farther down until the bladder is well clear of the cervix and moreover it must be carried out laterally to clear the ureters from the anterior aspect of the broad ligament and cardinal ligaments. This dissection is best carried out by the finger If traction is applied to the forceps on the uterine cornua, it will be easy to determine when the cervix has been reached as it can easily be felt through the anterior vaginal wall as soon as the bladder is clear of it The uterine vessels should now be clearly visible at each lateral angle and if the lateral angles have been swabbed clear to push away the ureters the forceps can be placed on the uterine vessels so that the tip of the forceps actually takes up the vaginal angle itself When the uterus is sufficiently mobile it is sometimes a great advantage to include the utero-sacral ligaments in the forceps taking the uterine vessels as there is frequently a small vessel in the utero-sacral ligament which may give rise to troublesome bleeding In a similar way a forceps is placed on the other uterine vessels in both cases keeping as close to the cervix laterally as is possible. These vessels are divided with a scalpel and it will be found a great help to apply traction to the forceps on the uterine cornua while these vessels are being cut as if this is done the uterus will be drawn much nearer the surface and the area of cleared vagina will be more readily accessible

covering posterior to the cervix An additional advantage of this suture is that *it rolls the raw surfaces of the stump inwards on to itself* as well as being hæmostatic.

The pelvic peritoneum may be closed in one of two ways and the length and mobility of the ovarian pedicles indicate which method to use. If they are sufficiently long and mobile easily to reach the stump of the cervix without tension a purse-string suture round each half of the pelvic peritoneum will effectively bury all the raw ends of the pedicle and will at the same time fix the ovarian vessels and round

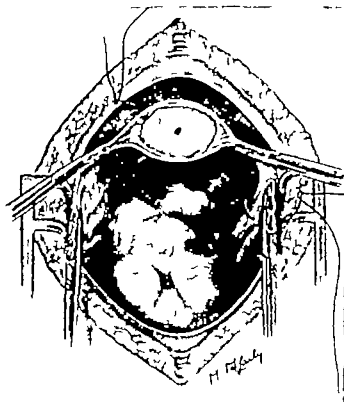


Fig 930.—The pelvis after subtotal hysterectomy showing the position of sutures in ovarian pedicle and round uterine artery

ligaments on to the stump of the cervix so affording a measure of support to the pelvic floor To insert this suture begin at the middle line of the posterior cervical peritoneum and taking stitches at about half inch intervals as near the free edge as is convenient pass the suture outwards along the posterior leaf of the broad ligament and through the peritoneum covering the ovarian vessels then transfix the round ligaments and end by taking two or three bites of the vesical peritoneal flap *Care must be taken to avoid puncturing the ovarian and uterine vessels.* This suture is tied and a similar procedure used for the other side. The result of this suture is a very

complete covering in of all the raw area and also the smallest possible intra peritoneal scar, with correspondingly low risks of subsequent adhesions

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Total hysterectomy—The bladder must be completely emptied for this operation which is started in an exactly similar manner to subtotal hysterectomy as far as separating the bladder but in a total hysterectomy this dissection must be carried out farther down until the bladder is well clear of the cervix and moreover it must be carried out laterally to clear the ureters from the anterior aspect of the broad ligament and cardinal ligaments. This dissection is best carried out by the finger If traction is applied to the forceps on the uterine cornua, it will be easy to determine when the cervix has been reached as it can easily be felt through the anterior vaginal wall as soon as the bladder is clear of it. The uterine vessels should now be clearly visible at each lateral angle and if the lateral angles have been swabbed clear to push away the ureters the forceps can be placed on the uterine vessels so that the tip of the forceps actually takes up the vaginal angle itself When the uterus is sufficiently mobile it is sometimes a great advantage to include the utero-sacral ligaments in the forceps taking the uterine vessels as there is frequently a small vessel in the utero-sacral ligament which may give rise to troublesome bleeding In a similar way a forceps is placed on the other uterine vessels in both cases keeping as close to the cervix laterally as is possible These vessels are divided with a scalpel and it will be found a great help to apply traction to the forceps on the uterine cornua while these vessels are being cut as if this is done the uterus will be drawn much nearer the surface and the area of cleared vagina will be more readily access

for the next procedure Having made sure that the bladder is clear of the vagina a stab incision is made anteriorly in the vagina and carried outwards to either side The vaginal portion of the cervix is seized with volsellum forceps and pulled upwards and forwards while the scalpel cuts through the posterior vaginal fornix and the uterus is removed. It is sometimes an advantage to place two or more forceps on the cut vaginal edge (Fig 931) particularly if the forceps on the uterine vessels have not quite reached the vaginal angle as in many

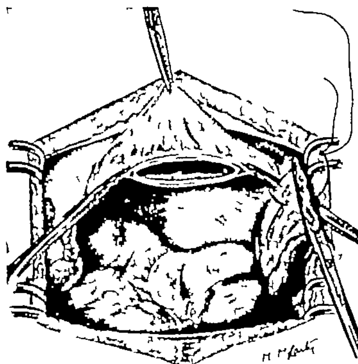


Fig 931 —The pelvis after a total hysterectomy The needle is shown transfixing the right ovarian pedicle the open vagina is seen.

cases there may be some bleeding from the vaginal edge and the assistant can by pulling on the vaginal edge make it easier to pass sutures

If the parametrium is bulky it is not safe to rely on one clamp and the uterine vessels are first secured separately a second clamp is placed in Mackenrodt s or the cardinal ligament as far as the lateral vaginal angle. It may even at times be advisable to secure the utero-sacral ligaments separately in Moynihan s forceps

Quite often the lateral angle of the cut vagina tends to retract and invert towards the vagina. This tendency must be controlled at all costs as it carries the descending vaginal branch of the uterine artery with it and if not secured is a common cause of secondary hæmorrhage after total hysterectomy

The ovarian vessels are ligated precisely as described in the operation of sub-total hysterectomy To ligate the uterine arteries the suture on a needle should be passed through the vaginal angle just below the point of the forceps and should then be tied surrounding the whole of the pedicle the forceps being released as it is tied The forceps should pick up the main vessels and after securely tying the first ligature the ends of the same ligature are used to encircle the uterine vessels as in sub-total hysterectomy The cut vaginal edges should be sutured together with interrupted sutures starting well out on the angle and taking the whole thickness of the vaginal wall

Some advocate leaving a portion of the vagina open for drainage but if the main vessels have been properly secured there will be nothing to drain as the sutures will stop all oozing from the cut vagina and drainage is unnecessary The peritoneum of the pelvic floor is dealt with in one of the two methods described in the operation for subtotal hysterectomy and the abdomen closed

Wertheim s hysterectomy.—This operation is one of the most formidable and severe in surgery and certainly in gynæcological surgery and for this reason the alternative method of treatment of carcinoma of the cervix by radium and X irradiation has been studied and developed to its present high standard. Certain cases of carcinoma of the cervix are best treated by irradiation while in others surgery holds out the better prospect The general condition of the patient should be considered. In carefully selected cases the results of the radical operation are as good as the results of irradiation

The patient must be catheterized immediately before the anæsthetic as in this operation it is most important that the bladder should not only be empty but should have contracted down to its smallest bulk If it happens to be fairly full when the patient is anæsthetized the catheter may empty the bladder but leave it flabby and uncontracted and occasionally half full of aspirated air A long acting spinal or extradural block is the most satisfactory anæsthetic combined with a light general anæsthetic to cover the discomfort of a steep Trendelenburg position When the patient is anæsthetized the vagina should be thoroughly cleansed and firmly packed with gauze soaked in an antiseptic (flavine and paraffin or violet green solution) The object of this pack is twofold first of all it helps to prevent the spill of cancer cells and organisms from the septic surface and also by distending the vagina it makes it easier to define this structure in the course of the operation The end of this gauze pack should be left long and should be placed between the patient s legs where it can be easily reached by an assistant whose duty it will be to remove the pack during the course of the operation After the abdomen has been generously opened the round ligament Fallopian tube and ovarian artery of the left side are seized in forceps placed across the top of the broad ligament about an inch from the uterine cornua The uterus is drawn to the right side thereby putting the round ligament

ovarian artery where the latter crosses the brim of the pelvis on the stretch The round ligament and ovarian vessels are encircled by a ligature on a needle as far out laterally as possible in order to remove as much of the cellular tissue of the broad ligaments as possible (Fig 932) The ureter must be defined as it crosses the pelvic brim before performing this manœuvre The upper outer border of the broad ligament is divided at this time (Fig 933) The uterus is drawn

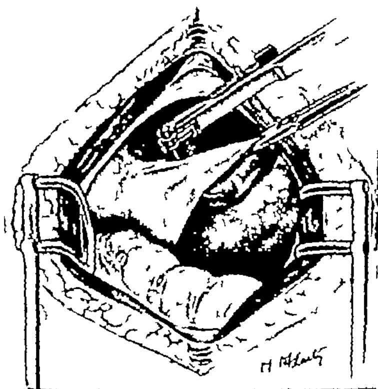


Fig 932 —Ligating the left ovarian pedicle.

still farther to the right and a ligature on a needle is passed deep to the utero-ovarian anastomosis about half way down the side of the body of the uterus. This ligature is tied and is then used to encircle the top of the broad ligament and the forceps on the latter are removed. A strong ligature is advisable and the ends should be seized in artery forceps as this ligature is required as a tractor later in the operation. The same manœuvres are carried out on the right side, and the two tractor ligatures are held in the same forceps. Traction is put upon them towards the patient s head to draw the uterus as high out of the pelvis as it will come in order to expose the peritoneum at the bladder reflection on the anterior surface of the lower uterine segment. The peritoneum is divided across the front of the uterus joining up to the cut anterior layer of the broad ligament It is then lifted towards the symphysis pubis and secured in this position by a stitch to the lower end

of the skin incision The plane of cleavage between the bladder and cervix is defined The bladder is separated from the cervix by blunt dissection in the middle line and is carefully extended laterally taking great care not to injure the ureters which may be closely adherent to the cervix and even involved in malignant infiltration If the bladder is actually involved it is usually advisable to abandon the operation or to consider the possibility of anterior exenteration

The next stage is to confirm the position of the ureters and define the

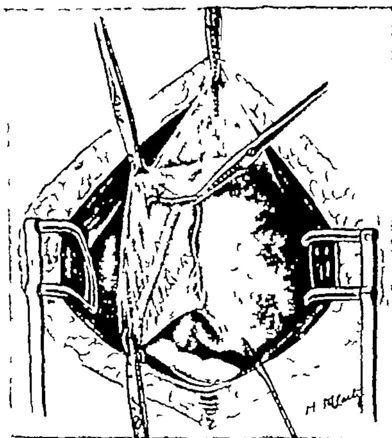


Fig 933 —Defining the uterine artery and ureter

uterine arteries The uterus is drawn to the right by traction on the tractor ligatures and held by an assistant The ligated ends of the round ligament and ovarian vessels are seized separately in artery forceps and the peritoneum between them is divided about an inch towards the lateral pelvic wall thus exposing the external iliac vessels. The peritoneum of the posterior layer of the broad ligament is seized in another pair of artery forceps and drawn gently towards the right. By blunt dissection with the fingers the layers of the broad ligament are further separated and the ureter is defined closely applied to the posterior layer of peritoneum of the broad ligament and is dissected out by blunt dissection It is then traced forwards and downwards until it passes deep to the main uterine vessels which come off the

anterior division of the internal iliac artery By blunt dissection the finger can be passed under the uterine vessels and can be made completely to encircle them The uterine vessels are then seized by two artery forceps and divided between the forceps Each end is ligated, as the uterine end will bleed if it is not for there is a free anastomosis with the vaginal arteries The uterine end of the uterine artery is again seized and drawn upwards which manœuvre will further expose

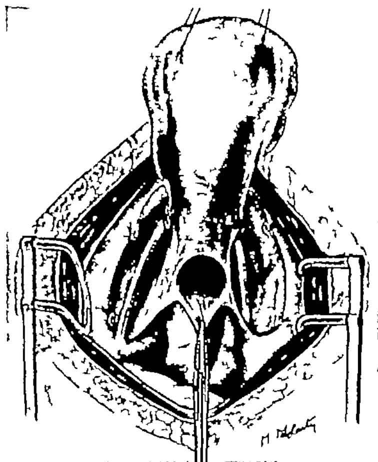


Fig 934.—Dissection between rectum and vagina the ureters are seen as well as the ligated main vessels.

the ureter which can be dissected out downwards and forwards until it disappears under a fairly strong band of connective tissue passing between the cervix and the angle of the bladder This bridge of tissue contains branches of the superior vesical artery and should be caught with artery forceps on the bladder side before it is divided. The ureter can now be traced forwards and inwards to the base of the bladder The same manœuvre is carried out on the opposite side

The uterus is now drawn forward towards the symphysis pubis and held there by an assistant The peritoneum covering the posterior vaginal fornix is seized in forceps and a definite line of demarcation

will be found between the adherent peritoneum of the cervix and the loose peritoneum covering the vagina A small incision is made in the peritoneum at about this point sufficient to allow the finger to be inserted and by blunt dissection the peritoneum of the pouch of Douglas is separated from the vagina and the incision widened to the full extent of the space between the utero sacral ligaments Two fingers can then be inserted and the blunt dissection carried down to separate

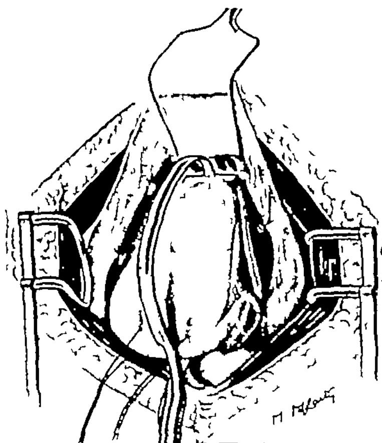


Fig 935.—Applying vaginal clamp.

rectum from vagina, as it is necessary to remove at least half and preferably two-thirds of the vagina (Fig 934)

The next manœuvre is to join the posterior peritoneal incision to the peritoneal incision in the posterior layer of the broad ligament One finger should be placed between the ureter and the posterior layer of the broad ligament and the other fingers in the dissection of the pouch of Douglas The hand is then pressed backwards towards the sacrum, guarding the rectum and ureter and then the peritoneum between the fingers is divided with scissors There is often quite a large vessel in the utero-sacral ligament which will require ligation. This manœuvre is repeated on the opposite side The uterus is now retracted towards the patient s head and a further dissection of the bladder from the anterior vaginal wall is carried out until a sufficient

anterior division of the internal iliac artery By blunt dissection, the finger can be passed under the uterine vessels and can be made completely to encircle them The uterine vessels are then seized by two artery forceps and divided between the forceps. Each end is ligated, as the uterine end will bleed if it is not for there is a free anastomosis with the vaginal arteries The uterine end of the uterine artery is again seized and drawn upwards which manœuvre will further expose

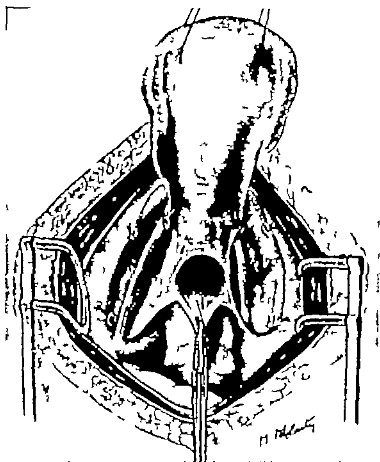


Fig 934.—Dissection between rectum and vagina the ureters are seen as well as the ligated main vessels.

the ureter which can be dissected out downwards and forwards until it disappears under a *fairly strong* band of connective tissue passing between the cervix and the angle of the bladder This bridge of tissue contains branches of the superior vesical artery and should be caught with artery forceps on the bladder side before it is divided. The ureter can now be traced forwards and inwards to the base of the bladder The same manœuvre is carried out on the opposite side

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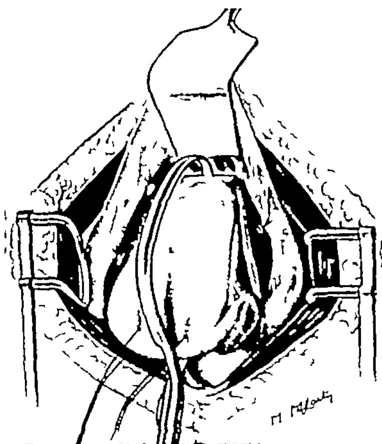


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amount of vagina is exposed. The uterus will now be found to be held in the pelvis by the two lateral expansions of the cardinal ligaments passing from the cervix and vault of the vagina below the ureter to the lateral pelvic wall. Where these ligaments join the pelvic wall, there is a plexus of veins which may give rise to troublesome bleeding and it is best to secure the cardinal ligaments close to the pelvic wall with angular artery forceps before dividing them. They are eventually

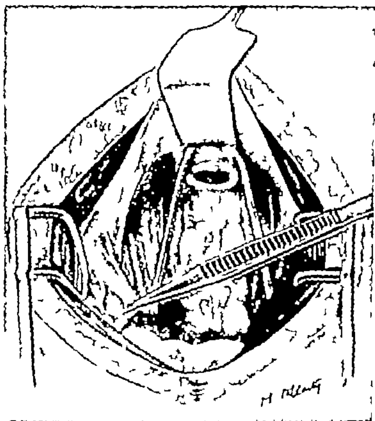


Fig 936.—Dissection of nodes from the iliac vessels. (The ureters should never be exposed to anything like the extent shown in the figure.)

divided right up to the vagina when the uterus and cervix will be found much more mobile and coming farther out of the pelvis. An assistant removes the gauze pack from the vagina and the vaginal clamp is immediately applied, so that any cancer cells or septic material in the vault of the vagina is shut in by the clamp (Fig 935). Angular forceps should be placed below the clamp on each side of the vagina, as there is commonly a vessel in this situation. These forceps are also useful in defining the vagina later on. The vaginal clamp is now used as a tractor and the vagina is cautiously cut through with a scalpel, or preferably diathermy as far down as possible and the uterus and upper half or two-thirds of the vagina is removed (Fig 936).

The next stage is to clear all cellular and glandular tissue from the external iliac vessels and the obturator fossa. The cellular tissue

covering the external iliac artery is lifted up and incised and by blunt dissection the external iliac artery and vein are cleared. The vein is the more vulnerable and care must be taken especially if a gland is at all adherent to it. If glands are adherent to the external iliac vein it is quite feasible to remove a section of that vessel with the glands *en bloc* No untoward consequences will be expected in the leg The writer has done this on several occasions. When the external iliac vein has been defined blunt dissection can be carried out immediately below it in the obturator fossa and all the cellular and glandular tissue must be dissected out The criterion of a good dissection is when the obturator nerve is cleanly exposed and isolated crossing the obturator fossa. Any bleeding points must be secured. A transfixion ligature at each angle of the vagina secures the branches of the vaginal artery If hæmostasis is good the vagina can be closed by sutures but if there is oozing it is advisable to control this with a small pack of gauze soaked in flavine the end of which is passed into the vagina which is left open The pack can be removed via the vulva 24 or 48 hours later Oxycel absorbable gauze is also useful in this position. In suturing the peritoneum to complete the pelvic toilet care must be taken not to injure the external iliac artery or a ureter both of these structures may be very near the peritoneal edge Before closing the peritoneum sulphonamide and penicillin powder can be sprinkled into the space between bladder and the rectum.

The abdomen is closed and the patient is nursed for the first 12 hours with the foot of the bed well raised A continuous blood-drip transfusion is of great value in combating shock. In the shocked patient transfusion is vital and the inhalation of a high concentration of oxygen by B L.B oro-nasal mask or oxygen tent equally important All patients treated by Wertheim s operation should be carefully examined for post-operative shock and the above measures should be employed as a prophylaxis The most important point in the after-care is the treatment of the bladder This organ is frequently paretic and is unlikely to function normally for two or three weeks and during this time it must not be allowed to become over-distended The catheter should be passed at four six or eight hourly intervals according to the amount of urine excreted by the kidney The bladder should not be allowed to contain more than 10 fluid ounces When the patient first voids urine spontaneously the bladder does not completely empty itself and it is of supreme importance that a catheter be passed immediately to remove the residual urine For this reason some surgeons prefer to have a self retaining catheter in the urethra for the first week or so This ensures an empty bladder and saves the patient the discomfort of frequent catheter passing or the risk of an over-distended bladder Urinary antiseptics are a wise precaution as is also prophylactic chemotherapy

Vaginal hysterectomy and plastic repair—Certain cases of prolapse at or near the menopause are especially suitable for vaginal

hysterectomy combined with plastic repair of the vaginal walls. The amount of prolapse should be considerable and the cervix should come down to the vulva. This operation is especially indicated if the prolapse is accompanied by uterine symptoms. On the whole, *malignant disease of the cervix is best treated by abdominal section* since the vaginal operation cannot be sufficiently radical to satisfy present-day standards The method is eminently suitable for cases of myohyperplasia.

The bladder is emptied by careful catheterization on the table. The labia minora are temporarily stitched back to keep them out of the way and the cervix is pulled firmly down by an assistant with volsellum forceps An incision is made from the urethra to the cervix in the anterior vaginal wall to the depth of the vesico-vaginal space. This incision is lengthened to encircle the cervix meeting again posteriorly and continuing as far down the posterior vaginal wall as necessary The posterior incision opens Douglas s pouch. Small toothed forceps retract the anterior vaginal wall and by sharp and blunt dissection the vagina is freed from the bladder as in Fothergill s operation. It is important to mobilize the bladder with the urethra and the sub-urethral ligament thoroughly from the vaginal wall both centrally and laterally (*see* Figs 905–6 pp 2149–50) When this is done the cervico-vesical ligament is divided with scissors and the bladder is separated from the cervix by blunt dissection with the thumb and pushed out of the way under the subpubic angle The utero-vesical peritoneum is identified and opened transversely and forceps placed on the bladder side of this incision. The utero-vesical opening is enlarged laterally and with a finger or volsellum forceps the uterine body is drawn through the opening and exteriorized. Stout longitudinally grooved clamps are applied from above downwards on the broad ligament The first contains the ovarian pedicle the second the uterine pedicle and the third Mackenrodt s ligament. The uterus is cut away inside these clamps and removed The pedicles are now individually secured with a transfixation suture of No 8 catgut and each pedicle is identified by a different pattern of forceps—small artery large Kocher and Moynihan —being applied from above downwards. In prolapse cases the surgeon now excises as much redundant vaginal wall as required to relieve the prolapse but leaving enough to provide against stenosis after suture

He then proceeds to pass a suture of No 8 catgut into the vagina just below the urethra taking a bite of the triangular ligament. This suture transfixes the utero-vesical peritoneum and passes through the triangular ligament and the vagina on the other side and is tied The next stitch below this takes a good bite of the lateral vaginal wall and transfixes the ovarian pedicles proximal to their ligatures thereby forming the apex of a shelf of broad ligament under the bladder The uterine pedicles and Mackenrodt s ligament are similarly transfixed and the anterior vaginal wall reconstituted by interrupted sutures. If there is a hernia of Douglas s pouch the redundant peritoneum of this sac is separately excised, the resultant opening being closed by

transfixion sutures. This hiatus can be more efficiently closed by passing two or three sutures through the utero-sacral ligaments the last suture is left long The posterior wall is now dealt with as in the ordinary posterior colpoperineorrhaphy If the patient is old and well past her sexual prime the lowest stitch in the shelf is anchored to the highest stitch in the levatores ani This manœuvre is very efficient in correcting prolapse of Douglas s pouch but it of course shortens and narrows the vagina. Whatever the indications may have been the aperture in the vaginal vault should be closed by suture. The danger in vaginal hysterectomy is ureteric damage and this risk can best be minimized by dislocating the bladder well away from the cervix as already described. The surgeon must also be very careful about hæmostasis Spouting vessels or free bleeding must be dealt with by finding the source and ligating In cases where there is great difficulty a clamp may be left on the vessel for from 48 to 72 hours depending on its size. A small persisting ooze may be controlled by a gauze plug soaked in flavine and paraffin passed through an interval in the vault the other end being brought out of the vagina. It should be removed in 24 or 48 hours

Patients can get up next day but if a prolapse repair has been done it is wiser merely to seat them and not to have them walking until the tenth or fourteenth day For the bladder continuous drainage by a self retaining catheter for four or five days is usual and this may be left in for 14 days if the patient has retention. The bowels are opened about the third day but enemas are avoided

Removal of the Vagina

This operation though popular on the Continent in the past as a means of treating prolapse has never been favoured by gynæcologists in this country There are however certain cases for which it is indicated, especially primary malignant new growths of the vagina itself or extensive downward invasion from the cervix in this case combined with vaginal hysterectomy When the patient is very fat and the vagina large this route presents certain advantages. In tractable stricture of the canal or destruction by scarring present further indications

Technique.—A circular incision is made round the vagina at the vulvo-vaginal junction and the vagina is freed by sharp and blunt dissection from the anal canal and the urethra. It is then packed with flavine gauze and the introitus closed with a strong suture which is tied and the ends left long for the purpose of traction Further dissection frees the back of the vagina from the rectum and the para vaginal tissue. The relation of the rectum to the vagina is deceptive and the surgeon should accept the help furnished by his own finger in the vagina. At this stage of the operation the surgeon if cramped for room can enlarge the operation space by making a paravaginal section usually on the left side from the postero-lateral aspect of the

hysterectomy combined with plastic repair of the vaginal walls. The amount of prolapse should be considerable and the cervix should come down to the vulva. This operation is especially indicated if the prolapse is accompanied by uterine symptoms. On the whole malignant disease of the cervix is best treated by abdominal section since the vaginal operation cannot be sufficiently radical to satisfy present-day standards. The method is eminently suitable for cases of myohyperplasia.

The bladder is emptied by careful catheterization on the table. The labia minora are temporarily stitched back to keep them out of the way and the cervix is pulled firmly down by an assistant with volsellum forceps. An incision is made from the urethra to the cervix in the anterior vaginal wall to the depth of the vesico-vaginal space. This incision is lengthened to encircle the cervix meeting again posteriorly and continuing as far down the posterior vaginal wall as necessary. The posterior incision opens Douglas's pouch. Small toothed forceps retract the anterior vaginal wall and by sharp and blunt dissection the vagina is freed from the bladder as in Fothergill's operation. It is important to mobilize the bladder with the urethra and the sub-urethral ligament thoroughly from the vaginal wall both centrally and laterally (*see* Figs 905–6 pp 2149–50). When this is done the cervico-vesical ligament is divided with scissors and the bladder is separated from the cervix by blunt dissection with the thumb and pushed out of the way under the subpubic angle. The utero-vesical peritoneum is identified and opened transversely and forceps placed on the bladder side of this incision. The utero-vesical opening is enlarged laterally and with a finger or volsellum forceps the uterine body is drawn through the opening and exteriorized. Stout longitudinally grooved clamps are applied from above downwards on the broad ligament. The first contains the ovarian pedicle the second the uterine pedicle and the third Mackenrodt's ligament. The uterus is cut away inside these clamps and removed. The pedicles are now individually secured with a transfixation suture of No 8 catgut, and each pedicle is identified by a different pattern of forceps—small artery large Kocher and Moynihan—being applied from above downwards. In prolapse cases the surgeon now excises as much redundant vaginal wall as required to relieve the prolapse but leaving enough to provide against stenosis after suture.

He then proceeds to pass a suture of No 8 catgut into the vagina just below the urethra taking a bite of the triangular ligament. This suture transfixes the utero-vesical peritoneum and passes through the triangular ligament and the vagina on the other side and is tied. The next stitch below this takes a good bite of the lateral vaginal wall and transfixes the ovarian pedicles proximal to their ligatures, thereby forming the apex of a shelf of broad ligament under the bladder. The uterine pedicles and Mackenrodt's ligament are similarly transfixed and the anterior vaginal wall reconstituted by interrupted sutures. If there is a hernia of Douglas's pouch the redundant peritoneum of this sac is separately excised the resultant opening being closed by

transfixion sutures This hiatus can be more efficiently closed by passing two or three sutures through the utero-sacral ligaments the last suture is left long The posterior wall is now dealt with as in the ordinary posterior colpoperineorrhaphy If the patient is old and well past her sexual prime the lowest stitch in the shelf is anchored to the highest stitch in the levatores ani This manœuvre is very efficient in correcting prolapse of Douglas s pouch but it of course shortens and narrows the vagina Whatever the indications may have been the aperture in the vaginal vault should be closed by suture The danger in vaginal hysterectomy is ureteric damage and this risk can best be minimized by dislocating the bladder well away from the cervix as already described The surgeon must also be very careful about hæmostasis Spouting vessels or free bleeding must be dealt with by finding the source and ligating In cases where there is great difficulty a clamp may be left on the vessel for from 48 to 72 hours depending on its size. A small persisting ooze may be controlled by a gauze plug soaked in flavine and paraffin passed through an interval in the vault the other end being brought out of the vagina. It should be removed in 24 or 48 hours

Patients can get up next day but if a prolapse repair has been done it is wiser merely to seat them and not to have them walking until the tenth or fourteenth day For the bladder continuous drainage by a self retaining catheter for four or five days is usual and this may be left in for 14 days if the patient has retention. The bowels are opened about the third day but enemas are avoided.

Removal of the Vagina

This operation though popular on the Continent in the past as a means of treating prolapse has never been favoured by gynæcologists in this country There are however certain cases for which it is indicated especially primary malignant new growths of the vagina itself or extensive downward invasion from the cervix in this case combined with vaginal hysterectomy When the patient is very fat and the vagina large this route presents certain advantages Intractable stricture of the canal or destruction by scarring present further indications

Technique.—A circular incision is made round the vagina at the vulvo-vaginal junction and the vagina is freed by sharp and blunt dissection from the anal canal and the urethra. It is then packed with flavine gauze and the introitus closed with a strong suture which is tied and the ends left long for the purpose of traction. Further dissection frees the back of the vagina from the rectum and the para vaginal tissue The relation of the rectum to the vagina is deceptive and the surgeon should accept the help furnished by his own finger in the vagina. At this stage of the operation the surgeon if cramped for room can enlarge the operation space by making a paravaginal section, usually on the left side from the postero-lateral aspect of the

vagina to the side of the rectum dividing the anterior fibres of the levator ani muscle (Schuchardt s incision) Brisk hæmorrhage will require individual ligation of vessels The dissection is continued upwards to find and open the peritoneum of Douglas s pouch which is temporarily packed. The surgeon now turns his attention to the anterior dissection separating the vagina from the bladder and cervix as in the operation of vaginal hysterectomy

The ureters will take care of themselves if the vesico-cervical ligament is properly divided and the bladder is pushed back by the fingers or gauze from the cervix until it disappears behind the subpubic angle. The ureters travel with the bladder and provided gentleness is observed, they are not likely to be torn. When the top of the vagina is reached it is cut across just below the cervix and is removed with the gauze pack *in situ* After attending to bleeding vessels the margins of the pouch of Douglas must be closed by a continuous suture drawn quite taut as it is introduced It is important that no gaps are left into which a portion of intestine or omentum might find its way and become incarcerated.

The large gap left after the excision may be variously treated If it is desired to restore the vagina for functional purposes the skin grafting method of McIndoe should be employed Where functional restoration is not a consideration subsequent steps depend on whether the uterus is present if it is a track must be left to the perineum for the escape of the menses or natural uterine secretion. A rubber tube should be placed in the cavity from cervix to outlet and packed all round with flavine paraffin gauze. This gauze must be changed every few days a gradually decreasing amount being introduced. In this way healing will be by granulation up to the tube. After the latter has been removed, probably by the end of a month the resulting narrow track must be kept patent by the passage of a sound or uterine dilator This will be required from time to time over a period of months but eventually it will naturally persist If the uterus has previously been removed or the operation of excision of the vagina is completed by vaginal hysterectomy the space left may be obliterated by the introduction of a series of buried sutures designed to draw the walls of the gap together or gauze packing may be used to assist the process of healing by granulation

If the growth which demands the operation is high in the vagina the surgeon may complete the operation by vaginal hysterectomy or he may decide on a combined removal. This will require the following three consecutive stages. First with the patient in the lithotomy position the *vagina is dissected free from below* as already described, its outlet being firmly closed by suture over gauze. Secondly with the patient in the Trendelenburg position the uterus is isolated and the broad ligaments securely ligated the dissection and separation is then continued downwards as in Wertheim s hysterectomy until it meets the separation carried out from below The uterus being quite free can now be drawn up through the abdomen together with the

vagina, the whole being removed *en masse* The pelvic part of the operation is now completed as described under the Wertheim removal and the abdomen is closed For the third stage the patient is again put up in the lithotomy position the light pack which was introduced below the isolated vagina is removed and the gap is closed as far as possible by a series of buried catgut sutures The edges of the levator ani muscles are carefully sutured together as are the superficial perineal muscles. There must be some provision for drainage.

Myomectomy

This operation consists in the enucleation of myomata or fibroids whether single or multiple from the uterus with repair of the internal wound and the preservation of that organ in a condition of functional activity

Myomectomy is now considered to be the treatment of choice in a woman of child bearing years suffering from fibroids. The number or position of the tumours is as a rule no contra indication to the operation These factors are merely a challenge to the dexterity and ingenuity of the surgeon

Every myomectomy is an individual problem and the surgeon must bear in mind that the operation when completed should leave the woman with a uterus capable of bearing children. If the finished operation is not likely to fulfil this criterion hysterectomy is a simpler and safer procedure

The steps of the operation may be epitomized as follows —

1 Opening of abdomen in middle line.
2. Examination of uterus to determine the location the size and number of the fibroids
3 Temporary hæmostasis by guarded clamps to ovario-pelvic ligaments on either side and by application of Bonney s myomectomy clamp
4 Incision of uterine wall with enucleation of tumours
5 Closure of enucleation cavities by deep catgut sutures for permanent hæmostasis and to obliterate dead spaces.
6 Reconstruction of uterus if required
7 Suture of primary uterine incision with accurate peritonization.
8 Removal of hæmostatic clamp final inspection and dealing with residual bleeding
9 Toilet of peritoneum.
10 Closure of parietal incision.

Technique.—The middle line abdominal incision should be generous and the bladder must be empty The uterus being delivered from the incision the tumours are inspected with regard to size and position in order to assess the best and safest means of enucleation. The question of the position of the uterine incision must be decided and the

control of hæmorrhage dealt with. It is a great advantage to operate in a bloodless field and this is achieved by temporary occlusion of the ovarian vessels by the application of guarded bowel clamps to the ovario-pelvic ligaments and the myomectomy clamp to the lower uterine segment and the round ligaments. Bonney s clamp is applied from the anterior aspect and should encircle the lower uterine segment just above the level of the internal os and should include in its grip both round ligaments. During the application the fingers of the left hand should be on the back of the broad ligaments and cervix to make sure that the blades are lying correctly When properly applied, this instrument, combined with clamps on the ovario-pelvic ligaments should give complete hæmostasis. They can safely be left on for an hour and the risk of infarction to the uterus and ovaries is so far as the writer knows practically negligible For the enucleation of the individual tumours a primary uterine incision must be made down to the tumour As soon as the latter is reached the uterine incision opens up by retraction and it is usually easy to find a natural plane of cleavage between tumour and uterine wall The actual enucleation may be carried out by the fingers or by some blunt flat instrument with a slight curve and nothing is better than a flat hernia director (Key s Cooper s or Wormald s) or Kocher s thyroid dissector The slightly curved handle of an ordinary tablespoon is excellent.

At the conclusion of the operation and when all the fibroids have been removed the enucleation cavities must be carefully and thoroughly obliterated by sutures passed through the full thickness of the myometrium on each side of the cavity and tied so that no dead spaces remain and that all oozing is arrested. The sutures are for approximation only and must not be tied too tightly or in a way that might strangulate a mass of uterine tissue for there is some risk of necrosis.

The most generally useful incision in the uterus is one on the anterior surface because by this route the fibroids in that situation can be dealt with first By an approach through the uterine cavity further tumours can be enucleated from the posterior wall without making a separate incision on the posterior peritoneal surface of the organ. Such a posterior incision should be avoided, if possible because of the danger of the small bowel becoming adherent to the scar with the risk of subsequent obstruction. But in certain cases such an incision is unavoidable as for instance when there is a posterior pedunculated subserous fibroid but it can often be covered by suturing the ovary and adjoining broad ligament over it. In order to minimize the danger of bowel adhesion and to ensure proper peritonealization Bonney has devised the hood operation In this method a transverse incision is made across the capsule of the fibroid as low down and as anteriorly as possible and after enucleation of the fibroid the capsule trimmed of its redundant myometrium is sewn over the uterus so that the apex of its lower end lies in the utero-vesical space Another manœuvre which is occasionally useful to keep the primary uterine incision of reasonable size is to remove the fibroid by morcellement. If the uterus

contains a large number of fibroids and individual enucleation is impracticable, it is often feasible to remove a block of the uterus containing the bulk of the fibroids *en masse*. This is done by hemisecting the uterus and then removing the middle parts of each half containing the fibroids and subsequently enucleating any fibroids remaining in each half by lateral tunnelling and finally reconstructing the uterus again by suturing the two halves together in the midline. This operation is particularly suitable for those cases in which the uterus is studded with many small fibroids.

The process of lateral tunnelling should be explained as follows. A midline incision having been made in the uterus and the most obvious fibroids removed, any interstitial fibroids lying laterally can be approached by secondary lateral incisions in the myometrium through the depths of the original incision. This process saves scarring the surface of the uterus with multiple incisions. Wherever the incision is placed great care must be taken not to damage the interstitial portion of the Fallopian tube.

At the conclusion of the operation it is a wise precaution temporarily to antevert the uterus by pleating the round ligament from the internal ring to the cornu of the uterus by a plication suture of No. 8 catgut. Cases have occurred where the uterus has retroverted after adhesion of the bowel to the scar, thereby causing a small gut obstruction; hence the importance of this step.

The surgeon must be prepared to deal with several types of fibroid, the more common of which are multiple anterior and posterior, fundal, anterior, central and posterior cervical, broad ligament and submucous. These types may occur singly or together and each demands certain modifications of technique.

Cervical fibroids constitute a special problem since about 5 per cent of all fibroids are so placed. If the cervical fibroid lies anteriorly the tumour can be approached by a transverse division of the utero-vesical peritoneum. It is impossible to apply Bonney's myomectomy clamp until the tumour has been enucleated. As soon as this has been done the clamp should be applied, hæmostasis is then secured and the enucleation cavity can be obliterated deliberately.

Should the fibroid be *central* in position, that is uniformly expanding the cervix around it with the uterus sitting on top of the expanded cervix like a cottage loaf, a different approach is necessary. The utero-vesical peritoneum is divided transversely as before and the round ligament may have to be divided also. To get at the fibroid it is necessary to bisect the uterus from above downwards and this will give an excellent approach to the bed of the tumour, which can now be enucleated and the myomectomy clamp immediately applied thereafter, enabling the whole organ to be reconstructed unhampered by blood loss and urgency.

If the fibroid lies *posteriorly* in the cervix it will have to be enucleated by a low posterior incision in the back of the uterus in Douglas's pouch

This may be vertical or transverse as the case decrees. Such an incision of course leaves a posterior scar which is unavoidable

Broad ligament fibroids are relatively easy to deal with because there is plenty of peritoneum available for covering the scar Three points must be stressed in these cases (1) hæmostasis (2) careful obliteration of the tumour bed otherwise a hæmatoma may form causing a stormy convalescence and (3) the danger of damage to the ureter which in certain cases may be displaced on top of the mass and cut across When incising the capsule in removal of a broad ligament fibroid, the ureter should always be identified in order that it may be kept out of harm's way

Submucous fibroids are best dealt with by the anterior transcavity approach.

In any myomectomy search must be made for small seedling fibroids which should be carefully removed They are best felt by palpating the uterus carefully between finger and thumb If this precaution is not taken small fibroids may be overlooked and will probably go on growing and require a further operation in the future.

Post-operative treatment and complications. Hæmorrhage.—There must always be some slight oozing from the uterine wound, but if the operation has been technically satisfactory this should never amount to a serious intra peritoneal hæmorrhage The abdomen should not be closed until the surgeon is satisfied with uterine hæmostasis.

Gaseous distension.—The operation is particularly associated with gaseous distension of the bowel and in some cases with paralytic ileus Peritonitis is fortunately a rare complication.

Adhesion of the small bowel to the uterine scar —This has been mentioned and is always a risk with posterior incisions.

Injury to the bladder and ureters.—This complication can arise when dealing with cervical and broad ligament fibroids

Damage to the Fallopian tubes.—Interstitial Fallopian tube damage by incision or suture must be most carefully avoided.

Bladder and bowel treatment.—The care of the bowels and bladder is the same as for hysterectomy

Results.—In Bonney's series of 806 operations (to January 1945) the mortality was 1 1 per cent Of the nine fatal cases two were from pulmonary embolism three from adynamic intestinal obstruction one from secondary hæmorrhage and one from necrosis of the uterine wall caused by the over use of mattress sutures. Two patients died of hæmorrhagic shock and both these were pregnant. It should be noted that myomectomy in pregnancy is a much more formidable operation

The greatest number of tumours removed at one operation was 225 in another case 40 tumours were removed, whose combined weight was 21 lb In one case the tumour proved to be a sarcoma.

Recurrence of fibroids after myomectomy—In a follow up of 379 patients Bonney gives a figure of under 4 per cent. recurrences and this figure should be accepted as fair if the operation has been thoroughly performed. Seven patients suffered from menorrhagia one of which needed hysterectomy

Pregnancy after myomectomy—Bonney records that of his follow up of patients 187 being married and of child bearing age and who wished to become pregnant 52 conceived after the operation and 34 were

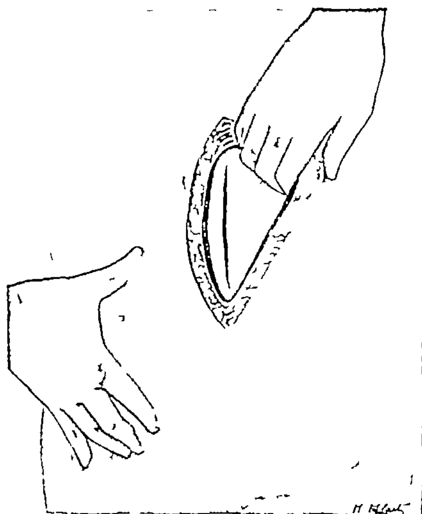


Fig 937 —Incision for classical Cæsarean section.

delivered normally Cæsarean section was performed in 17 cases and there was one miscarriage The indication for Cæsarean section was relative and due to the high value of the child. Normal delivery after myomectomy is to be expected and Bonney does not record rupture of the uterus although this is a remote possibility The uterus should not behave abnormally in labour but there is perhaps a little increased risk of post partum hæmorrhage or abnormal adherence of the placenta if conception occurs soon after the myomectomy

No description of the operation of myomectomy is complete without paying tribute to the pioneer work done in this country by Victor Bonney and any surgeon who is contemplating the operation is advised to read his *Technical Minutiæ of Extended Myomectomy and Ovarian Cystectomy* (Cassell & Co 1946) The operation is one of the great advances in the conservative pelvic surgery of women and has been responsible for a great many children who would otherwise never have been born.

Cæsarean Section

Classical Cæsarean section.—Recent correspondence has suggested that the classical operation should never be performed and that the lower segment Cæsarean section should entirely replace it. The writer cannot agree with this dogmatic statement. Most gynæcologists rightly prefer the lower segment operation because of its many advantages—for instance minimal risk of subsequent rupture in future pregnancies less liability of adhesion formation greater safety in the potentially infected case and the formation of a better scar in an inert part of the uterus. For the expert gynæcologist these advantages are obvious. For the occasional operator however the classical operation is quicker and easier to perform than the lower segment and for these reasons will still occasionally save the life of mother and child. The classical operation is usually performed before the onset of labour or only just after labour has started and before rupture of the membranes A midline incision is made in the abdominal wall from a point about 2 in. above to another point about 2 in. below the umbilicus going just to the left of the umbilicus itself and the abdominal cavity is opened (Fig 937) The uterus should next be centralized as at term this organ is usually markedly on the right side of the abdomen It can be easily centralized by the assistant placing his hand well to the right flank and pushing it towards the left It is then incised by two or three sweeps of the knife. No attempt should be made to seize any bleeding points at this stage as any such efforts will be quite fruitless. Care must be taken when the membranes are exposed or the fœtus may be cut The incision must be carefully carried through the whole thickness of the uterus throughout the length of the incision The operator then inserts his hand into the uterus and identifies a leg and extracts it breech first Some difficulty may be experienced in freeing the arms They can however be readily hooked out by the hand which is not holding the breech and the child delivered.

The child should be held head downwards to allow liquor and mucus to run out of its mouth and air passages and should be kept head downwards until it is breathing well. The umbilical cord is clamped with two Spencer Wells forceps and cut between them and the child handed to an assistant The finger is then placed in the upper angle of the uterine incision and the uterus delivered through the incision in the abdominal wall. It should then be wrapped in warm towels

and compressed laterally which will usually expel the placenta and control bleeding (Fig 938) The membranes usually separate easily and care must be taken to ascertain that they are complete especially that the membranes lying in the lower uterine segment are removed

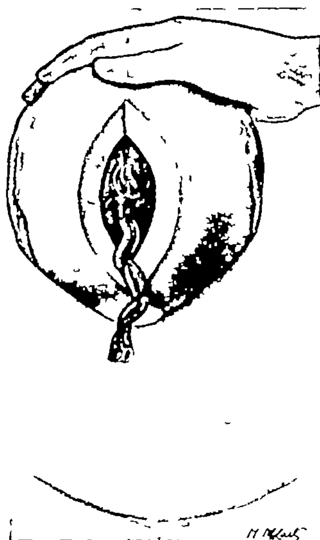


Fig 938 —Expressing the placenta.

In some cases the placenta and membranes are unusually adherent and it may be necessary to peel them off with a swab When they have been removed the uterus should be again compressed and wrapped up in warm towels to aid retraction and control bleeding The incision in the uterus is closed in two layers with No 2 or No 3 catgut (chromicized) The first layer of sutures must take in muscle only and care must be taken that the suture does not encroach on the endometrium as if it does an intra uterine stitch sinus may result (Fig 939)

The second layer of sutures starts from the peritoneal surface of the uterus takes in at least half the thickness of the muscle of the uterus and when it is tied, if the sutures have been accurately placed will give good peritoneal apposition Usually six or eight of these sutures will be necessary to secure good closure. Further peritonealization can be secured by a Lembert s suture of fine catgut covering the knots

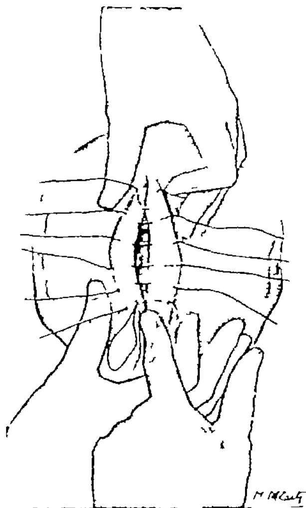


Fig. 939.—The first layer of sutures.

of the second layer of sutures (Fig 940) The uterus is again compressed between towels to secure retraction and to express any accumulated blood clot. It is then returned to the abdomen and the abdominal wound closed.

Modification of classical Cæsarean section.—This modification is recommended by the writer The obvious criticism of the above operation is that blood and liquor are allowed to enter the general abdominal cavity with the dangers of general peritonitis and subsequent bowel adhesion and possibly later intestinal obstruction. The eventration of the uterus may cause shock.

A low midline subumbilical incision is employed As soon as the abdomen is opened a large roll of gauze soaked in saline solution is packed all round the uterus so as to retain the bowels and absorb any blood and liquor which is lost. The uterus is then incised vertically from the utero-vesical peritoneum upwards for a distance sufficient to deliver the fœtus This incision cuts through the lower uterine segment when present and the isthmus of the uterus and a little of the

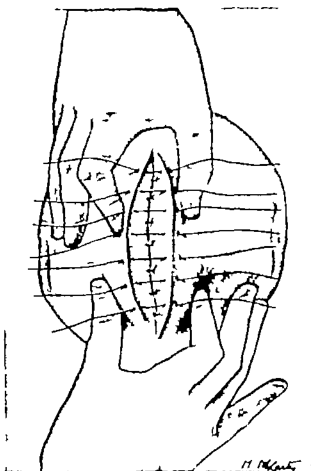


Fig 940.—The first layer of sutures tied : second layer inserted.

body of the uterus When the membranes present they are ruptured and the head is delivered by a combination of fundal pressure through the abdominal wall assisted by the operator s hand, or in cases of difficulty by Willett s scalp forceps. After delivery of the child the blood and liquor are sponged and sucked out of the uterus. If the uterus retracts well the placenta soon separates and is expressed by the operator s right hand placed outside the abdominal wall. He should never put his hand into the general abdominal cavity nor should he ever touch the bowels If the uterus is not retracting well ergometrine 0 5–1·0 mgm is injected direct into the myometrium or 0 5 mgm is given by the anæsthetist intravenously When the

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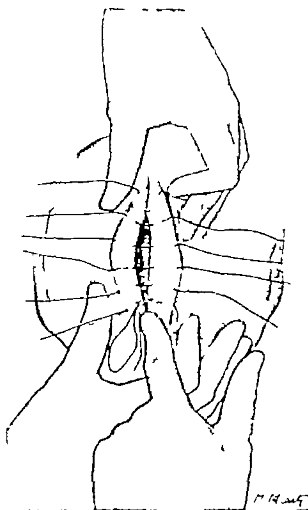


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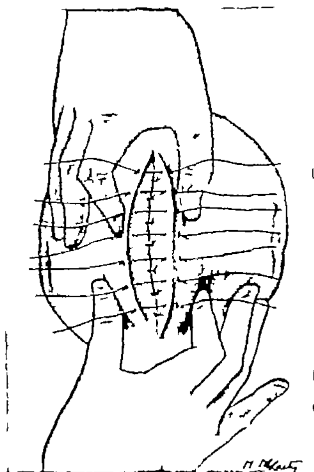


Fig 940 —The first layer of sutures tied second layer inserted.

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placenta and membranes have been delivered the uterus is sutured in three layers The first layer of sutures takes the full thickness of the myometrium and nothing else and consists of a series of interrupted sutures of No 2 or No 3 catgut as many as are needed to control the bleeding The second layer consists of continuous oversewing sutures of No 2 or No 3 catgut which by taking a more lateral bite act as an inverting Lembert suture. This is the water proofing suture. The third layer is a continuous suture which includes peritoneum only and is naturally more easy to place in the lower reaches of the incision than the upper because of the looseness of the peritoneum over the lower segment When the uterine wound is clean and dry the roll gauze pack is removed and the abdomen closed in layers No drainage is employed.

This modification of the classical operation is employed by several surgeons and combines many of the advantages of the classical and the lower segment operation.

Lower segment Cæsarean section.—The lower segment operation is more suitable for patients who have been in labour for some hours in fact, it is only after some hours labour that the true lower segment develops. A midline incision about five inches long is made from a point an inch or two below the umbilicus to the upper border of the symphysis pubis. The abdomen is opened and the wound retracted to expose the uterus. The peritoneal reflection in the utero-vesical pouch is easily defined and the loose peritoneum in this area is incised transversely (Fig 941) The uterine muscle is then cautiously cut through transversely The incision should be curved with the convexity downwards as in this way there is less danger of injuring the uterine arteries and veins (Fig 942) The incision is carried cautiously through the thickness of the uterus until the fœtal scalp can be just seen through the membranes The incision should now be completed throughout its full width with scissors The fœtal head can be levered through this incision using one blade of the obstetric forceps as a vectis or the fœtal scalp can be seized with Willett s scalp forceps and by gentle traction drawn up through the incision. Once the head has been delivered the rest of the delivery is simple

The child and cord are treated as described in the classical operation but the placenta and membranes may be dealt with in one of two ways. If the patient is a suspect case the placental end of the cord should be cut off as close to the placenta as convenient and left in the uterus The uterine incision is closed with a catgut suture and the placenta later expressed through the vagina. If the case is not suspect the placenta and membranes may be removed through the incision forthwith The hand is inserted and the edge of the placenta felt for The placenta is then peeled off the uterine wall and removed through the incision.

An alternative method of dealing with the placenta and membranes when the time factor does not operate against the surgeon is to allow

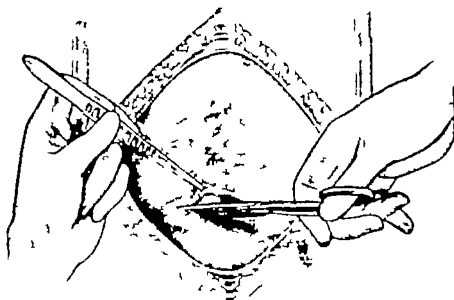


Fig 941 —Incising the loose peritoneum.

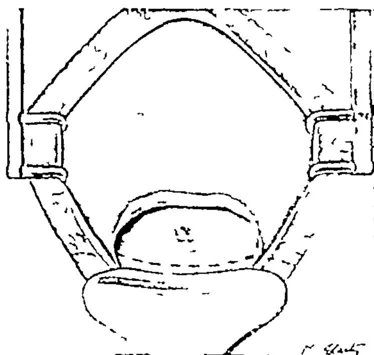


Fig. 942 – Dotted line shows position of curved incision in uterine muscl

the uterus to retract and expel the placenta into the uterine wound of its own accord. This process can be expedited by the surgeon expressing the placenta through the abdominal wall as described in the modified classical operation This last procedure is preferable to the two already described in that it obviates the risks of what amounts to a manual removal of the placenta on the one hand and does not leave the expulsion of the placenta entirely to the uterus on the

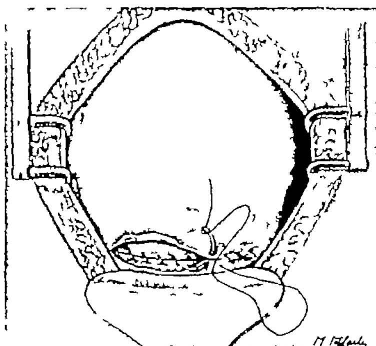


Fig 943 —The uterine muscle is sutured : suturing the peritoneum.

other This latter procedure which fulfils the most rigid criteria of asepsis runs the risk of the placenta being retained when the abdominal operation is completed Should post-operative hæmorrhage then result the serious and difficult undertaking of manual removal would be necessary

The method of closing this incision differs considerably from that described for the classical operation but resembles that employed in the modified classical operation.

Shortening the Round Ligaments
Modified Gilliam s Operation

Some cases of retroversion and retroflexion of the uterus are well treated by an operation for pleating and fixing the round ligaments. After opening the abdomen in the middle line the left round ligament is picked up fairly close to the lateral pelvic wall and a running suture is passed through it four or five times right up to the uterine cornua.

When this suture is tied the ligament will be pleated A non absorbable silk or thread ligature is preferable one end being left about eight inches long and a similar manœuvre carried out on the right side. A pair of curved forceps (round ligament forceps) is passed deep to the fascial sheath of the rectus abdominis muscle and superficial to the belly of the muscle to the internal abdominal ring The point of the forceps is then manœuvred through the ring and between the layers of the peritoneum of the broad ligament A small incision is made in the peritoneum close to the pleated round ligament and the point of the forceps is passed through this opening The ends of the ligature are seized by the forceps and the forceps withdrawn, thus telescoping the pleated round ligament into the broad ligament through the internal abdominal ring and under the sheath of the rectus This manœuvre is repeated on the opposite side The ends of the ligatures which were left long on the round ligaments are then threaded on needles and the skin and subcutaneous fat dissected from the anterior surface of the rectus sheath about an inch and a half laterally on each side the needles carrying the sutures are passed from below upwards through the sheath of the rectus and tied on the anterior surface thus fixing the pleated round ligament to the anterior abdominal wall. Although this technique is rather difficult to describe it is really quite straightforward.

VI OPERATIONS ON THE OVARIES

Ovariotomy

This operation is usually carried out under general anæsthesia but it can be done under spinal regional or even local infiltration

The abdomen should be opened by a midline incision Ovarian cysts are sometimes of great size and for large ones it is particularly important to make a midline incision as in order to deliver the cyst the incision may have to extend from the ensiform cartilage to the symphysis pubis. Moreover with a large cyst *it is not possible to* determine from which ovary it has arisen and the pedicle may be very short and almost inaccessible through a paramedian incision on the wrong side Further it is not possible to distinguish a parovarian or broad ligament cyst from an ovarian cyst and a broad ligament cyst may be inaccessible through any but a median incision

It is a general practice to endeavour to remove an ovarian cyst unruptured as however innocent a tumour may appear externally there is always the possibility that parts of it are highly malignant and the spill of fragments of carcinoma in the peritoneal cavity may result in metastases With modern mechanical suction apparatus it is at times permissible to reduce the size of a very large cyst by puncture and aspiration The cyst should be delivered through the wound and its pedicle clamped with one two or more pressure forceps and the cyst removed (Figs. 944 and 945) The pedicle is then transfixed and

ligated with as many transfixion ligatures as may be necessary to secure hæmostasis If the pedicle is very broad care must be taken to ensure that the ureter is not looped up in the pedicle. Sometimes adhesions are found Usually they are easily separated but they may require clamping and cutting and subsequent ligation. Any bleeding points must be secured and ligated.

Broad ligament cysts must be shelled out The peritoneum covering the cyst should be carefully incised and by digital dissection the cyst can be completely separated from its bed provided sufficient care is

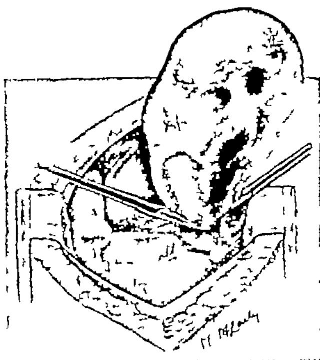


Fig 944.—Clamping the pedicle of an ovarian cyst.

used to avoid rupture Bleeding points in the wall of the bed must be carefully secured and ligated. The peritoneum is sutured to cover the raw area. If good hæmostasis has been secured, no other treatment is required, as the intra abdominal pressure will cause the space to collapse. If hæmostasis is not satisfactory the space should be temporarily drained through a stab wound well to the side of the anterior abdominal wall. Sometimes these cysts burrow under the ureter and this structure must be located before anything is clamped or cut

Further considerations.—When operating on ovarian cysts the surgeon should first make an incision large enough to insert his hand and explore all surfaces of the cyst. He should inspect and palpate the other ovary In addition to this he should make thorough and careful exploration of the peritoneal cavity omentum and liver especially if he is in the least suspicious of malignancy If he is

dealing with a huge ovarian cyst and his preliminary exploration has satisfied him that it is benign he can proceed according to two principles first to enlarge the incision sufficiently to deliver the whole cyst through the wound and remove it entire or secondly to tap the cyst with a trochar and cannula after careful packing of the site of the puncture so that any spill of cyst contents does not soil the peritoneal cavity Great stress has been laid on the danger of peritoneal irritation peritonitis and implantation of malignant cells by tapping or rupture of a malignant cyst and certain cysts when ruptured (notably

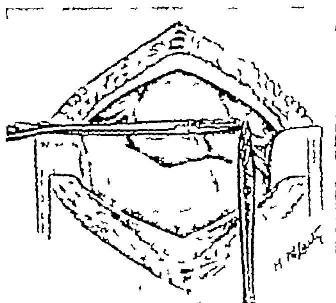


Fig 945.—The pedicle after the cyst is removed.

pseudo-mucinous cysts) have been considered responsible for the condition of pseudo-myxoma peritonei It is probable that these dangers are exaggerated and that tapping is a sound procedure in certain cases if the cyst is thought to be benign and care is taken not to soil the peritoneal cavity It is unwise to tap a cyst which has acquired adhesions to other viscera which prevent its delivery

A benign cyst has a smooth pearl-coloured capsule there are no hard, solid areas in it and as a rule no adhesions Any papillomatous processes on its surface immediately suggest malignancy though histologically they may be benign

If there are any adhesions present between the cyst and viscera or parietal peritoneum these must be freed by blunt or sharp dissection. Unless the cyst is frankly malignant these adhesions do not present great difficulty In some malignant cases it is impossible to free them nor does it matter since in these cases metastases are almost always widespread

Having freed the cyst it should be delivered either entire or after tapping and the uterus and other ovary should be inspected. Many ovarian tumours tend to be *bilateral* such as endometriosis dermoids

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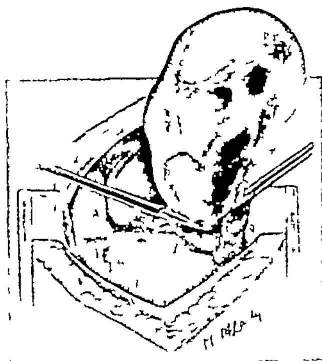


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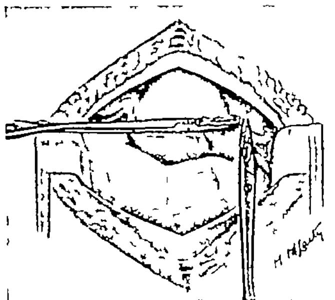


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and carcinoma. If the patient is young as much ovary as possible must be conserved. If she is past the menopause and if there is any possibility of malignancy it is probably wise to perform a pan hysterectomy In all cases of unilateral ovarian carcinoma, whatever the age of the patient, both ovaries and uterus should be removed by this operation.

Technique of dealing with the pedicle.—The pedicle of an ovarian cyst may be thick and contain large dilated veins and lymph vessels or it may be thin and elongated If too big a bite of the pedicle is taken in when it is thick there is a risk of vessels retracting and causing a hæmatoma. It is therefore wisest to proceed by taking a few of the vessels in a small bite at a time and it is always a sound precaution to perform double ligation Should a vessel retract, the pedicle must be immediately clamped higher up with due respect to the presence of the ureter If this manœuvre is insufficient the two leaves of the peritoneum covering the pedicle should be widely separated immediately and the offending vessel found clamped and tied.

When it is certain that complete hæmostasis has been assured the pedicle should be buried under the peritoneum by the same technique as that by which the appendix stump is covered, in order to prevent adhesions forming between the pedicle and the bowel.

The most difficult cysts to deal with are endometriomatous cysts because of the dense adhesions which occur between these cysts and the parietes the bowel and bladder In some cases the pouch of Douglas is obliterated in an inseparable adherent mass of colon small bowel uterus endometriosis and parietal peritoneum. The surgeon must explore every aspect of the tumour until he can find a plane of cleavage and he must enlarge this plane in all directions until he can mobilize the cyst. In spite of this he is likely to rupture the cyst and soil the peritoneal cavity with the tarry contents This tarry fluid should be removed by a sucker since its presence in the peritoneal cavity may give rise to subsequent adhesion formation and will certainly increase the risk of a stormy convalescence and the possibility of paralytic ileus. If the bowel is inadvertently damaged the rent must be noted and immediately sutured and in some cases though rarely resection and anastomosis will be necessary If the large bowel is damaged it should be immediately sutured and it will be wise to provide drainage to the site of the injury If the rectum is damaged in the depths of Douglas s pouch and suturing is not considered adequate drainage and temporary colostomy may be wise.

OVARIAN CYSTECTOMY

In the past when a surgeon has encountered an ovarian cyst his usual reaction has been to remove the cyst and the ovary The sexual youth of the patient has not tempered this surgical expediency and the surgeon has been happy to salve his conscience with the thought that his patient possesses another ovary In this way many ovaries have been

sacrificed unnecessarily in the removal of benign cysts for which a local enucleation would have been surgically sufficient.

Cases selected for cystectomy must be obviously innocent tumours such as cystoma simplex pseudo-mucinous cyst adenoma and dermoids and occasionally corpus luteum cysts if of sufficient size to cause symptoms. The patient should be in her sexual prime and not over 40 years of age unless there is some special indication for conservatism at a later age. Ovarian cystectomy becomes the operation of choice if a woman develops a cyst in her sole remaining ovary where its fellow has been extirpated by surgery or destroyed by disease Sufficient ovarian residue must be left after the cystectomy to provide a useful functional organ otherwise oöphorectomy is the better operation It is however surprising what considerable sexual function can be derived from a mere fragment of an ovary Cysts which show degenerative or inflammatory changes are as a rule unsuitable for cystectomy but may sometimes be treated by block or wedge excision of the cyst and adjacent ovarian tissue.

Cases unsuitable for ovarian cystectomy are solid ovarian tumours with the exception of fibromata non-encapsulated ovarian tumours endometriomatous cysts in which conservative surgery is unfortunately almost always followed by recurrence of the original condition All cases are subject to the age limit and remarks made above

Technique. **Operation in a bloodless field**—This is secured by placing a bowel clamp across the ovarian pedicle after delivering the tumour through the abdominal wound

Enucleation.—A very light cut is made over the capsule of the cyst great care being taken not to make a hole in the cyst By preserving the cyst intact enucleation is much easier and there is no risk of leaving any of the lining membrane Should a hole unfortunately be made this should be immediately sealed by some forceps such as Duval s lung forceps or sponge-holding forceps Ordinary Spencer Wells forceps tend to tear another hole in the cyst wall.

A plane of cleavage between the ovarian tissue surrounding the cyst and the cyst wall itself is readily available and this should be gently explored and extended by the handle of the knife closed scissor blades or the finger and this process proceeds to complete enucleation

Sometimes there is an area of adhesion between the cyst and the ovarian tissue which is so intimate that separation is impossible In this case the area of adhesion should be isolated by a circular incision and removed undamaged with the ovarian cyst (*see* Fig 946) The cyst having been removed the ovary is inspected for further tumours and these are enucleated.

Reconstruction of the ovary—The surgeon will now be left with a thin ovarian capsule which surrounded the cyst in certain parts of which is a thicker area of ovarian residuum in the region of the hilum

That part of the capsule which is so thin as to be relatively functionless may be excised. The bed of the cyst is obliterated and rendered hæmostatic by a series of light tension sutures (Fig 947) after which the clamp is removed and complete hæmostasis secured by further suturing If the enucleation has been made through the correct plane

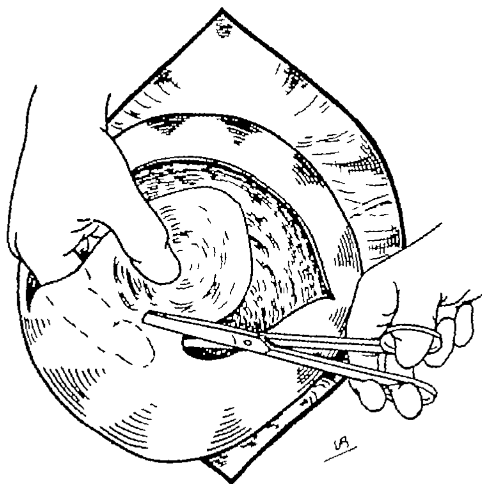


Fig 946.—Ovarian cystectomy Isolating the area of adhesion of cyst and ovarian tissue surrounding it.

(Figs. 946-8 from Bonney Technical Minutiae of Extended Myomectomy and Ovarian Cystectomy Cassell.)

bleeding will be slight If the cyst has been large the ovary will be represented merely by a capsule of thinned-out ovarian tissue and very little else. The ovary may now be likened to an envelope from which the gum has been steamed and the four flaps opened. It should be reconstituted by putting the flaps back and anchoring the four pieces by suture This will leave a flat ovary which can be further enfolded until an organ somewhat resembling the original is left (Fig 948)

Certain cysts are best dealt with by partial or wedge excision of a portion of the ovary and this applies to those cases of endometriosis in which conservative surgery is performed. That part of the ovary

containing the cyst is excised and the wound in the ovary closed by a series of interrupted sutures using No 0 catgut and a fine round bodied needle. Cutting needles should always be avoided and the sutures should be tied firmly but lightly otherwise the ovarian substance will be cut through

Persistent oozing from the ovarian wound can be controlled with

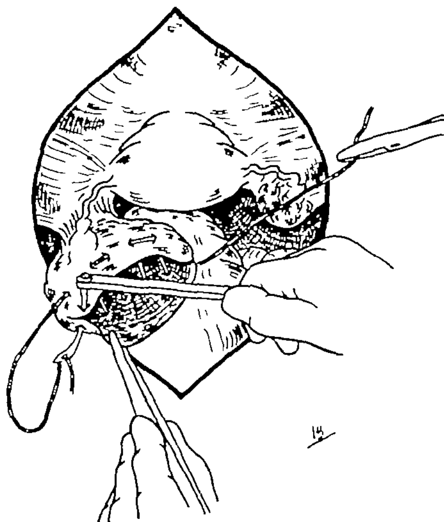


Fig 947 —Ovarian cystectomy Application of light tension sutures to render the bed of the cyst hæmostatic.

fibrin foam or Oxycel or if the surgeon prefers it the application of an omental graft lightly sutured over the raw bleeding area.

The operation is best completed by the plication of the round ligaments in order to keep the uterus anteverted

Salpingectomy

The removal of the whole or part of the Fallopian tube for pyosalpinx or ectopic gestation is a simple operation in the absence of adhesions and provided it is carried out under the guidance of vision with the patient in the Trendelenburg position. Some adhesions may

be separated by gentle manipulation with the fingers perhaps aided by a swab More dense adhesions may be best divided with scissors. When the tube is freed, the mesosalpinx is clamped with one forceps and another is placed on the junction of the tube to the uterine cornua.

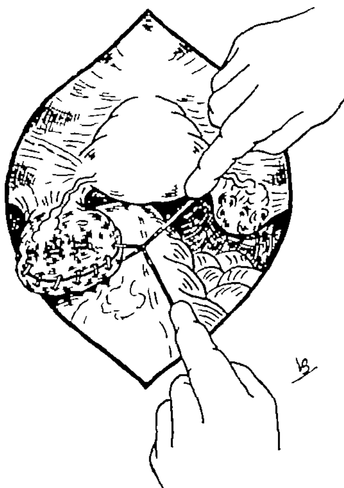


Fig 948 —Ovarian cystectomy Reconstruction of the ovary completed.

The tube is then cut off with either scissors or a scalpel and the tissues enclosed in the forceps ligated with a simple transfixion ligature.

SALPINGO-OÖPHORECTOMY

In some cases the ovary is so completely involved that it is necessary to remove it as well as the tube Adhesions are freed as above the ovarian pedicle is seized with one pair of forceps and another pair is put on the tubo-ovarian ligament and upper edge of the broad ligament close to the uterine cornua. If care is taken to see that this forceps includes the utero-ovarian anastomosis *and the ligament* of the ovary there will be no bleeding when the tube and ovary are removed, and the tissues may be tied off with ligatures as above It may sometimes

happen that a vessel in the ovarian pedicle slips out of the ligature and retracts in which case a hæmatoma will form between the layers of peritoneum In such a case the simplest procedure is to pick up the ovarian vessels half an inch above the upper limit of the hæmatoma and pass an encircling ligature round them and tie the vessels in continuity The surgeon must satisfy himself by observation that hæmatoma is not increasing If there is any doubt about this the peritoneum must be incised clots removed and the actual bleeding point discovered and tied.

Operations for Pyosalpinx

Operations for pyosalpinx may be extremely difficult and rank amongst the most hazardous in pelvic surgery The dense adhesions involving large and small bowel omentum bladder uterus and appendages and parietal peritoneum render exact anatomical definition almost impossible. In some cases the pelvic viscera are embedded in a cement like exudate—the concrete pelvis of American writers

Certain guiding principles may help the surgeon in dealing with such a case. Having opened the abdomen with great caution for fear of damaging adherent bowel in the region of the incision the fundus of the uterus should if possible be identified. To do this it is often necessary to free the omentum which completely covers the whole pelvis below the abdominal incision. If the omentum is absolutely adherent it must be cut and ligated until the proximal part of the omentum can be freed and packed off into the general abdominal cavity This will provide access to the uterus and appendages. Sometimes it will be found that the appendix is involved in the general inflammatory process and the question of appendicectomy calls for nice surgical judgment It may have to be removed and the slightly increased risk of peritonitis following appendicectomy in such a case incurred Routine appendicectomy in these cases is to be deplored. Large and small intestine must now be separated from the inflammatory mass and great care must be taken in this part of the operation in order to avoid damage to the bowel When the gut has been separated it should be packed off into the upper abdomen and the surgeon must now endeavour to free the diseased appendage mass from its adhesions in the pouch of Douglas and to the back of the uterus and parietal peritoneum. The side which is most easily freed should be chosen first and the best dissector is the gloved finger nails of the index and middle fingers of the right hand. During this process care should be taken not to rupture the tube although this contretemps need not disturb the operator since the pus is bacteriologically sterile in all but the most recent cases. If the tube has been ruptured the pus should be swabbed away By proceeding cautiously and patiently and exploring the most promising planes of cleavage the surgeon will eventually deliver the appendage first on one and then on the other side. A decision must now be made as to what must be removed

and this will be influenced by the extent of the disease and the age of the patient. In bilateral pyosalpinx both tubes must be removed as conservative surgery cannot expect to achieve any functional efficiency in the tube. In young women it is almost always possible to save part of the less diseased ovary but sometimes both appendages will have been converted into a tubo-ovarian abscess which is best removed bilaterally In such a case the presence of the uterus serves no good purpose and better hæmostasis and a cleaner operation can be achieved by the operation of panhysterectomy Moreover in these cases the uterus is itself involved in the inflammatory process and if conserved will merely become a source of future mischief By leaving the vagina partially open drainage can be provided to the most dependent part of the peritoneal cavity Once the appendage masses are delivered the operation proceeds as described in salpingo-oöphorectomy and hysterectomy

Dangers of the operation. Injury to large vessels.—This can only occur if the operator fails to find the plane of cleavage between the parietal peritoneum and the inflammatory mass. In so doing he may damage the great vessels of the internal iliac network or even the external or common iliac vein. This catastrophe is best avoided by finding a plane of cleavage downwards and backwards between the inflammatory mass and the pelvi rectal colon. Apart from damage to large vessels the raw bed from which the mass has been excavated may ooze freely This oozing occurs from dilated veins and can usually be controlled by placing a swab rung out in warm aqueous acriflavine over the bleeding area. If this is ineffective a piece of Oxycel sprinkled with penicillin and sulphathiazole powder is often most useful In circumstances of exceptional difficulty a long artery forceps may be left on a bleeding point the handles being brought out of the lower part of the abdominal wound. Such hæmostatic forceps may be loosened in 49 hours and if there is no further bleeding removed about two hours later If the surgeon is gentle and confident anæsthesia is not required.

Injury to the gut.—In disentangling the bowel from the mass the peritoneal coat may be stripped down to the muscle or a hole may be torn in the bowel wall. If the peritoneal coat is merely damaged it is sufficient to cover the raw area with omentum or omental graft. Owing to the friability of this part of the bowel suturing is usually impracticable If the cut muscle is damaged a fæcal fistula may result or peritonitis develop An attempt should be made to suture the muscle in the hope that the stitches will hold without cutting through and free or grafted omentum may be sewn over the damaged area. A soft rubber drain may be laid through a stab wound down to the damaged area. If the mucous membrane has been damaged an attempt must be made to close the hole but in the small bowel resection and anastomosis may be necessary with large bowel drainage to the damaged area and relieving colostomy

Damage to the ureter—This may occur because the ureter itself has been involved in the inflammatory process This possibility should be borne in mind before applying the clamp to the ovario-pelvic ligament and in all cases where the lateral parietal peritoneum of the pelvis has been injured. If there is any doubt the pelvic ureter should be defined and inspected throughout its length

Salpingostomy

Attempts to cure sterility due to blocks in the Fallopian tubes have so far only met with moderate success and each case must be dealt with on its merits Should the Fallopian tube be blocked only at the fimbrial end it is comparatively easy to perform salpingostomy The tube is slit up for about an inch and with fine catgut the peritoneal coat is sutured to the mucosa. When the block is nearer to the uterus or in its wall other operations have been devised and practised but they are often complicated and of very doubtful utility and are certainly not recommended for general use

VII OPERATIONS FOR STERILIZATION

It is surprising that short of hysterectomy no operation for sterilizing a woman can be an absolute guarantee against future conception Relatively safe methods however include partial or complete bilateral salpingectomy if special care is taken to bury the interstitial part of the tube after it has been ligated, under the peritoneum which is sewn over the stump with a fine purse-string suture of catgut In some cases hysterectomy is as good and safe a way of producing sterilization as any

Temporary Sterilization

It may very occasionally be justifiable temporarily to sterilize a woman and for this purpose the fimbriated ends of the Fallopian tube can be buried between the layers of the broad ligament in such a way that at a future date they can be liberated. The first step is to divide the ovarian fimbria and about an inch of the mesosalpinx at the fimbriated end of the tube The cut portion of the mesosalpinx attached to the tube is ligated and the ends of the ligature left long A small incision is made into the peritoneum between the tube and the round ligaments and with a finger or blunt dissector the layers of the broad ligament are separated. The long ends of the ligature are then threaded on needles Each needle is passed to the lowest point of the dissection and the threads brought out through the anterior layer of the broad ligament so that when they are tied together the fimbriated end of the Fallopian tube is buried between layers of the broad ligament. A few fine sutures are employed to close the incision in the peritoneum and to anchor the Fallopian tube still more securely The abdomen is closed in the usual way Not all gynæcologists will

agree that this operation is justifiable and some say that it may lead to the development of hydrosalpinx and necessitate subsequent operation Another criticism is that modern contraceptive methods can achieve the same end without the discomfort and danger of opening the abdomen.

VIII PRESACRAL SYMPATHECTOMY

Most surgeons are conversant with the technique of this operation. Its indications in gynæcological practice are few being mostly in cases of intractable dysmenorrhœa in which at least two dilatations of the

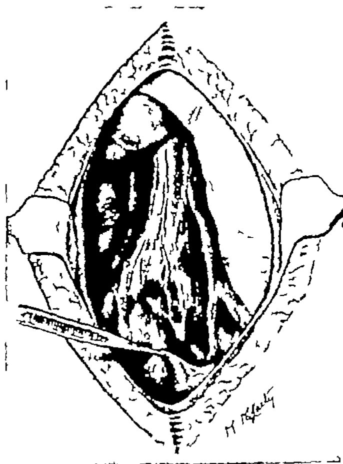


Fig 949.—Presacral sympathectomy

cervix have failed to effect a cure. O Donel Browne has pointed out that the pain fibres of the uterus do not all run in the presacral plexus and that in many cases of dysmenorrhœa the ovarian nerves form the pathway If therefore the case is severe enough to warrant neurectomy it is probably reasonable to section the ovarian nerves as well as the presacral nerves

The technique of the operation is to open the abdomen by a para median para umbilical incision with the patient in the Trendelenburg

position The ovario pelvic ligaments are clamped on both sides to a depth of about 1 in and divided It is essential to identify both ureters before carrying out this step and the later stages of the operation The ligated ends are secured by a transfixation suture and tied, and the stumps of these pedicles are inverted by a purse-string peritoneal suture which buries them The ovary now obtains its blood supply from the uterine ovarian anastomosis and there need be no fear of infarction of the organ The bifurcation of the aorta is now identified and the bowel packed away to the left The peritoneum between the two common iliac arteries is incised vertically and all the cellular tissue in which the nerve fibres are imbedded in the space bounded laterally by the two common iliac vessels posteriorly by bone and anteriorly by peritoneum is excised (Fig 949) Great care must be taken not to damage a ureter or the superior hæmorrhoidal artery Many small vessels will be divided and are best sealed by diathermy coagulation When the space is quite clear and is free from oozing the peritoneum is closed by a continuous suture no drainage is necessary O Donel Browne claims that this operation has no ill effect upon subsequent childbirth nor is there any reason why it should have It does however cause menorrhagia and irregular menstruation for from three to six months presumably owing to a sympathetic release causing vaso-dilatation of the ovarian vessels. After this menstruation returns to normal. If carefully performed, the operation in most cases cures the hypogastric pain of dysmenorrhœa, but it will have little effect on the distant manifestations of this largely psychosomatic disorder such as gastro-intestinal upset headaches depression and malaise

IX ACCIDENTS DURING OPERATIONS

During the course of gynæcological operations neighbouring structures are sometimes accidentally damaged, particularly the rectum bowel bladder and ureters Damage to these structures may have very serious results not only in immediate complications but also from fistulæ which may be exceedingly difficult to close

Rectum.—The rectum is very rarely damaged in perineorrhaphy even if it is it is unusual for the result to be serious if the injury is noticed at the time and repaired. If not noticed it is likely there will be an infection of the operation area which may result in a good deal of suppuration but is unlikely to give rise to a permanent fistula. If there is suppuration the ultimate result will not be as satisfactory as if healing were by first intention but quite likely the end result will be surprisingly good. The rectum may also be injured in abdominal operations Inflammatory and malignant masses may be adherent and attempts at removal may open the rectum It is obvious in such a case that there is a considerable risk of infecting the peritoneal cavity and giving rise to general peritonitis If the rent is observed

and carefully sutured there is a chance that no ill effects whatsoever will follow If repair is difficult or uncertain external drainage should always be provided A temporary colostomy is often a wise safety measure

Bladder —The bladder may be accidentally incised or torn during the operation of anterior colporrhaphy Fothergill s operation or vaginal hysterectomy Great care is needed when operating on a case which has previously been treated surgically Such damage should be immediately repaired and treated as in the operation of vesico-vaginal fistula, by continuous drainage through an indwelling catheter for 12 or 14 days. If the damage to the bladder has not been noticed at the time of operation and a vesico-vaginal fistula subsequently results the treatment will be as described for this condition (p 2156)

The bladder may be damaged when the abdomen is opened, but this accident should be very rare if the following three points are observed (1) that the surgeon should always empty the bladder himself with a metal or glass catheter on the table immediately before opening the abdomen (2) that the primary incision in the peritoneum is made in the region of the semi lunar fold of Douglas and (3) that the surgeon extends this incision downwards cutting through the peri toneum which is held up against the light Operating in this way injury to the bladder will be very unlikely

The bladder may also be injured during the process of separating it from the cervix in total hysterectomy and Wertheim s hysterectomy If not noticed and dealt with at the time peritonitis or an immediate fistula may follow But fistulæ are not always produced in this way and sometimes occur as a result of bruising and subsequent avascular necrosis of the damaged area. In such cases leakage usually appears about 10 days after the operation or rather later This type is particularly difficult to cure and may need uretero-colic im plantation. This is especially so if the bladder has been infiltrated by growth or involved in inflammation

Ureter —Ureters are rarely injured in vaginal operations but such accidents have been recorded after anterior colporrhaphy Fothergill s operation amputation of the cervix and vaginal hysterectomy The ureter may be partly or completely included in a suture or ligature Attention to technical detail will minimize this risk almost to vanishing point. In abdominal operations the ureter is liable to be injured in two common situations In total and Wertheim s hysterectomy it may be injured by inclusion in a clamp or ligature near the uterine vessels and more rarely at the angle of the vaginal vault A rarer injury occurs at the brim of the pelvis when the ovario-pelvic ligament is clamped. This is particularly liable to occur when operating on cases of endometriosis where the dense fibrous adhesions have distorted the tissues and drawn the ureter out of its anatomical position. Broad ligament tumours and cysts sometimes burrow under the ureter which may be cut when incising the peritoneum over these tumours or during

the process of enucleation This structure is more liable to be torn when it is involved in inflammatory conditions such as pyosalpinx

It has already been emphasized that during these operations the ureter should be identified before anything is clamped or cut and it is only at risk when operating blindly If the ureter is cut low down it is usually not too difficult to re implant it into the bladder and additional length can be obtained for this implantation by freeing it from its pelvic bed for a few inches. If the ureter is cut too high for implantation into the bladder it is probably best to implant it into the colon at once rather than risk the dubious results of uretero-ureteral anastomosis which often results in obstruction and hydropyonephrosis and leads to subsequent nephrectomy

X MORTALITY

Gynæcological operations are fortunate in having a low mortality—in vaginal operations a fraction of 1 per cent and abdominal operations apart from Wertheim s hysterectomy in the region of ½ per cent The classification of the cause of the mortality and morbidity is as follows —

1 Chest complications and pulmonary embolism which provide the black spot in gynæcological surgery

2 Post-operative shock is becoming a rarer complication with the improvement in anæsthetic practice and the routine employment of blood transfusion in severe cases

3 Local and general peritonitis is also yielding ground to the use of chemotherapy

4 Hæmorrhage is as a rule attributable to inadequate hæmostasis and faulty technique in the ligation of vessels

5 Urinary infection though present after many gynæcological operations is rarely severe enough to cause anxiety or danger

6 Paralytic ileus and acute dilatation of the stomach occur occasionally in quite unexpected cases but these complications are amenable as a rule to continuous gastric and duodenal suction and intravenous fluids

7 There remains a vague group of bad risk patients who will always be a surgical anxiety and this includes those with severe cardiac or pulmonary damage diabetics thyrotoxics and the obese hypertensive

CHAPTER XL

OPERATIONS ON THE KIDNEY AND URETER

By the late JOHN EVERIDGE
Revised by HENRY K VERNON

I OPERATIONS ON THE KIDNEY

Preliminary examination—The preliminary examination in operations on the kidney involves complicated methods of diagnosis. These include cystoscopy with all its allied methods radiography alone urography by the excretion or ureteral catheterization technique and estimation of the renal function By these methods which cannot be described here the surgeon before operation should be in possession of complete knowledge about the following points

1 The diagnosis of urinary as opposed to extra urinary disease.
2. The differentiation of vesical ureteral and renal disease.
3 The localization of disease to one or both kidneys
4 The nature of the renal disease.
5 The estimation of the extent of the renal disease
6 The estimation of the total renal function and that of each kidney

By the use of modern methods the diagnosis is complete before operation and only on the rarest occasions is exploration of the kidney —formerly so common a method of diagnosis—now performed

Preparation of the patient.—The preparation of a patient for a kidney operation involves preliminary treatment of the bowel and the renal function and appropriate measures to combat urinary sepsis.

Treatment of the bowel is important as distension of the gastro-intestinal tract is a frequent sequel to operation on the kidney It is a distressing and may be a serious and even fatal complication. When the intestinal tract is already in good order it is sufficient to empty the bowel by an efficient purge and an enema

The purge should be given at least thirty-six hours before the operation and should consist of an efficient dose of castor oil or a vegetable laxative such as colocynth and hyoscyamus in a pill. Salts should not be given as they are uncertain in action and tend to produce flatulent distension. After the purge the diet should be moderate and starchy foods such as untoasted bread and potatoes green vegetables and uncooked salads should be avoided

On the morning of the operation the lower bowel should be cleared by a small enema.

Treatment of the renal function by quantities of water or waters like *Vittel Contrexéville* and *Vichy may be necessary* but the

administration of too much fluid is apt to produce distension of the bowel and should on this account be carefully watched

Urinary antiseptics should be administered as a prophylactic before many operations on the urinary tract hexamine or the sulphonamide group being preferred It is wiser to discontinue thirty six hours

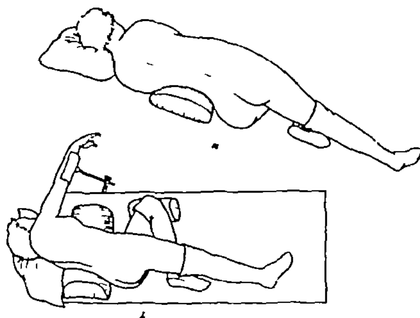


Fig 950 —Posture for Lumbar Exposure of the kidney
(a) The lower loin is raised as high as possible to procure the widest costo-iliac space
(b) The lower leg is acutely flexed, and with a sandbag under the knee the tendency to rotation is overcome, the ankle being anchored under the fully extended upper thigh.

before major operations all those likely to interfere with renal function and to substitute alkalis as a defence against acidosis and renal failure Glucose and pre-operative drinks provide additional security In a few cases of severe hæmaturia the hæmoglobin content may be so lowered that a preliminary blood transfusion is necessary

Position of the patient on the operating table —The usual incision for the exposure of the kidney is in the lumbar region and the patient must lie on the sound side In order to increase the space between the last rib and the iliac crest a support is placed under the loin. (Fig 950*a*) Edebohls rubber air bag or the triangular air cushion originally designed by Dr David Newman (Fig 951*a*) may be used Every modern operating table is equipped with some form of metal support for the loin

In the kidney position the lower hip and knee are fully flexed and the upper thigh and leg extended in the axis of the body Sand pillows are placed in front of the upper knee and beneath the lower knee to prevent the patient rolling Alternatively a piece of adhesive strapping is placed across the buttocks and fixed to each side of the

operating table Carter Braine s rest is used to support the arm and prevent the arm and shoulder falling forwards. (Fig 950*b*) This allows free play to the chest and greatly assists the anæsthetist The rest is a flat metal plate which is pushed beneath the under shoulder To this is attached a rod which carries a metal gutter on which the arm rests (Fig 951*b*) The gutter can be raised or lowered.

The ventral position is sometimes used the patient lying prone with the head turned to one side and the arms alongside the body In this position an Edebohls bag is placed under the abdomen

The dorsal position is used in abdominal exploration of the kidney

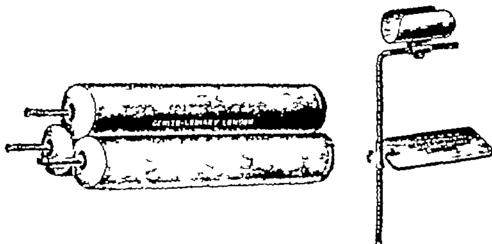


Fig. 951 (*a*) —Newman s kidney air-cushion. Fig 951 (*b*) —Carter-Braine s arm-rest.

Lumbar incision.—Two points form landmarks for the commencement and termination of the incision namely the angle between the *erector spinæ mass of muscle and the 12th rib and the anterior superior* iliac spine The line of skin incision may be curved oblique transverse vertical or T shaped (Fig 952.)

The curved incision makes most use of the valuable space in the loin and can be extended forwards The oblique incision approaches too near and is limited by the iliac crest The transverse incision does not take advantage of the recess between the erector spinæ and the ribs. The vertical incision gives a limited exposure. The T shaped incision is suitable when additional space to that provided by the curved incision is necessary

The *oblique incision is used where the costo-*iliac space is wide. The incision commences at the angle formed by the last rib with the erector spinæ muscle and passes downwards to a point on the crest of the ilium 2½ in posterior to the anterior superior iliac spine

The transverse incision is more suitable where the costo-lumbar space is narrow It commences at the edge of the erector spinæ mass of muscles and passes transversely forwards midway between the crest

of the ilium and the tip of the last rib for 8 or 8½ in A transverse incision is useful in large renal growths in children It can be extended forwards to meet the amount of space required It also is useful when an intraperitoneal exploration is required

A very long oblique incision was used by the earlier surgeons Morris Kelly Albarran and Israel in exploring the kidney and ureter This lumbo-ilio-inguinal incision corresponded in its upper extent to the curved incision but continued downwards far into the inguinal region even to the edge of the rectus abdominis When more room is required a short vertical incision is made upwards from the oblique wound extending sufficiently over the 12th rib

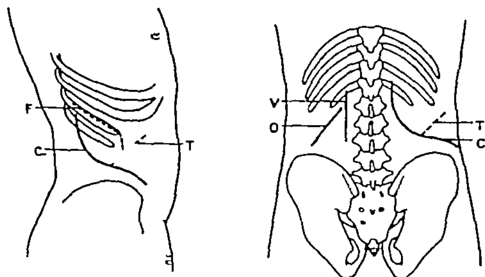


Fig. 952.—Incisions for exposure of the kidney C, the curved incision usually adopted by the writers still better approach to the pedicle may be gained by adding T a transverse incision. V and O vertical and oblique incisions. F the 11th costal incision of Bernard Fey the anterior division of muscles is increased as required

The curved incision has been used by many surgeons and has been subject to considerable modification W J Mayo used a curved incision which commences at a point 2 to 2½ in. lateral to the dorsal spines near the outer margin of the erector spinæ The incision lies behind the 12th rib and reaches downwards to a point ½ in below the angle From this point the incision passes obliquely downwards and forwards along the anterior margin of the quadratus lumborum to a point ½ in above the crest of the ilium thence turning forwards parallel to the iliac crest as far as necessary

We employ a similar incision but take the angle between the 12th rib and the erector spinæ as the indicator and commence 1 to 1½ in above this over the 12th rib or last intercostal space The incision (Fig 952) after passing vertically to a point midway between the last rib and the crest of the ilium curves sharply outwards parallel with the crest The importance of carrying the incision well up over the

the convex margin of the kidney and its anterior surface The further procedure will depend upon the object of the operation

Difficulties and dangers of the operation.—In a thick loin with little space between the 12th rib and the iliac crest the available area for operation may be much confined so that the wound is a deep and narrow one This difficulty may also be encountered when the cushion under the loin is too soft or not sufficiently high or when it is

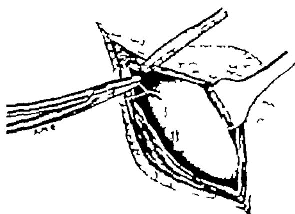


Fig 954—Undersewing the subcostal artery Often required after division of the external arcuate ligament, a necessary step in the upward dislocation of the last rib for better exposure of the kidney

so broad as to prop up the lower iliac crest and ribs instead of pressing well into the loin By carrying the incision well forwards and freely retracting the muscles and turning the colon forwards out of the way a better exposure will be obtained in a difficult case

There may be persistent bleeding from a vein in the upper cut edge of the internal oblique This muscle retracts upwards beneath the external oblique and disappears from view

Injury to the peritoneum may occur from neglecting to separate it from the abdominal wall before cutting the muscles. The opening is at the anterior angle of the wound and a coil of the small intestine appears at this spot Or there may be firm adhesions between the peritoneum and the anterior surface of the kidney and in the process of separation it is opened This is most likely in secondary operations on the kidney and there is also danger of injuring the peritoneum at the costal margin when much scar tissue is present

Firm adhesions to the duodenum or colon have been responsible for injury to these viscera in the process of separation of the anterior surface of the kidney and exposure of the renal pedicle.

If it is important to examine the abdominal aspect of the kidney its vessels or lymphatics advantage should be taken of an accidental opening into the peritoneal cavity by enlarging the gap and introducing the hand

An opening in the peritoneum may have to be made deliberately for exploration In this case the colon is defined and the peritoneum picked up and incised in front of it One of us (J E) has five times successfully removed a gall bladder for cholelithiasis and frequently the appendix in this way Rarely is use made to-day of this means of ascertaining the existence of an opposite kidney

The pleura may be wounded at the upper angle of the wound This is most likely when there is a very short 12th rib or during excision of this rib With moderate care this is not difficult to avoid in a straightforward case Mayo records 18 cases of injury to the pleura in 208 lumbar incisions This large number may be accounted for by the fact that in 51 cases it was found necessary to divide the 12th rib Should this accident occur a gauze pack is immediately introduced into the opening while preparations are made for suture Closure is usually simple and is effected by introducing No 2 catgut sutures upon a short fully-curved needle through the edges of the gap in the membrane including in these the muscular coverings to give a better hold of the sutures The approach to the pleural opening where the Fey incision was used is easy and allows ready closure

Closure of the lumbar incision.—The muscles are united by interrupted catgut sutures about one to the inch passed by large curved needles. The sutures take up the whole thickness of the muscular abdominal wall and are clipped and put aside until all are passed

Care should be taken that the internal oblique which always retracts upwards beneath the external oblique is not missed by the needle

When all sutures are passed the opposite loin is lowered the edges of the lumbar wound fall together and the sutures are tied A few secondary stitches may be required to close superficial gaps or a second continuous layer taking the fascia over the external oblique on either side and so inverting the muscle edges may be used

Drainage is carried out by a medium-sized rubber tube with lateral opening or a strip of corrugated rubber This should if possible be placed at the posterior extremity of the lumbar wound and usually lies behind or below and behind the kidney

In nephropexy the kidney is fixed at the posterior surface and the drain must be anterior to the organ and will reach the surface most easily about the middle of the wound When the renal pelvis has been opened the drain should lie behind the kidney and the end is carefully adjusted to lie close to the posterior aspect of the pelvis.

It is occasionally possible to dispense with drainage in such cases as nephrectomy for tuberculous disease and for growths.

2. *Renal pain* definitely localized either recurrent or continuous where no undue mobility stone new growth hydronephrosis tuberculosis or pyogenic inflammation has been found by the various non operative methods of examination

Attention has been drawn by S H Harris* and others to painful dysfunction of the neuro-muscular mechanism of the renal calyces pelvis and perhaps the ureter as well By pyelography and pyeloscopy abnormal systole and diastole may be observed believed to be responsible for severe colicky pains. Renal sympathectomy (*see* p 2271) may not only relieve the pain but is accredited with restoring in certain cases a natural architecture as proved by subsequent pyelography

3 In *obstructive anuria* the side of obstruction may be suggested only by slight pains or discomfort and operation takes the form of an exploration followed by nephrostomy

DECAPSULATION OF THE KIDNEY

This operation is practised in some cases of anuria and in some cases of non infective nephritis especially the type now known as nephrosis characterized by high albuminuria and extensive œdema but uncomplicated by nitrogen retention and cardio-vascular changes Eclampsia appears to have benefited little if at all by this operation

The kidney is exposed by a short incision it is not necessary to deliver it into the wound (*see* p 2232) A small incision is made in the capsule and a blunt dissector introduced beneath the capsule along the outer border of the kidney The capsule is cut with scissors along the groove and the incision carried round each pole The capsule is then picked up with fine forceps and gently separated with a spatula care being taken not to tear the kidney tissue nor to detach portions of the cortex with the capsule The latter is stripped anteriorly and posteriorly as far as the hilum and clipped away otherwise there is a risk of the capsule eventually causing constriction of the renal vessels if it be left *in situ* A good deal of oozing occurs from the stripped surface but there is no serious bleeding Perinephric fat is removed to provide a more vascular bed for one object of the operation is to give an additional blood supply

Difficulty may arise from adhesion of the capsule and in cases of contracted kidney from long-established interstitial nephritis this is not infrequent In nephrosis the capsule strips with ease

Bilateral operation is necessary where decapsulation is employed. Both kidneys are usually decapsulated at the same time with the patient on the operating table in the prone position but occasionally it may be considered necessary to defer operation on the second kidney until the first wound is healed

* *Proc Roy Soc of Med* 1935, xxix, 673.

NEPHROPEXY

The operation of nephropexy is justified where symptoms or pathological conditions are present that can be assigned to the mobility of the kidney. A movable kidney that is part of a general enteroptosis is unsuitable for operation unless pain is very definitely referred to the kidney and is unrelieved by other methods. Where there are known to be extensive adhesions of the bowel and a movable kidney the case is seldom suitable for nephropexy.

The cases suitable for nephropexy are patients with undoubted movable kidney where there is pain referred directly to the kidney or where the attacks known as Dietl's crises occur and especially if urography shows hydronephrosis. Nephropexy should only be done for mobility when every other source has been clearly excluded and even so it must be combined with a careful exploration.

Where pain is the only symptom present it is relieved by rest in bed in full recumbency in all cases likely to be permanently alleviated by operation. This should be used as a test for the suitability of the case for nephropexy.

Fixation may be necessary after plastic operations for hydronephrosis and after symphysiotomy of a horseshoe kidney (*see* p 2275).

The operation consists in the suspension or fixation of the kidney either by the use of structures already present in the body or by the production of inflammatory tissue that will become fibrous or by the use of foreign material. A very large number of operations have been introduced many of which are only slight modifications of previous methods. For information on these the surgeon is referred to the older text books.

Technique.—A curved lumbar incision is made of sufficient length to expose the 12th rib and give free access to the kidney and its surroundings (*see* p 2221). Dilatation of the renal pelvis kinking or narrowing of the uretero-pelvic junction adhesions and aberrant vessels are all excluded by thorough examination.

The surface of the quadratus lumborum and of the psoas is completely cleared of fat and areolar tissue by stroking it downwards with a dry gauze swab. The kidney is delivered from the wound and turned over the lower ribs with the posterior surface displayed. With a light touch the fibrous capsule is incised so as to include an area of the posterior surface extending from pole to pole and from the hilum to within an inch of the convex border. The capsule is raised with forceps and gently stripped backwards from the edge parallel to the outer border of the kidney towards the hilum (Fig 955). At points along the incision and where the capsule dips into a fissure between congenital lobules scissors will be required.

That part of the capsule which has been stripped back to the edge of the hilum is cut away. Three sutures of supple No 4 catgut are passed through the kidney substance about ¾ in from the convex

border and within the area of attached capsule The upper suture lies near the upper pole the intermediate about the middle of the convex border and the lower near the lower pole

The kidney is now replaced and the surgeon carefully fits it into the position in which it lies most easily The upper pole will be beneath

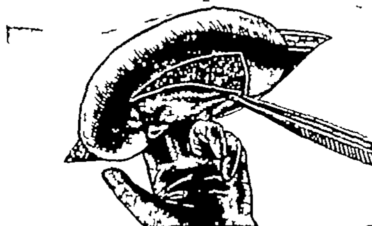


Fig. 955.—Nephropexy stripping of capsule on posterior surface of kidney

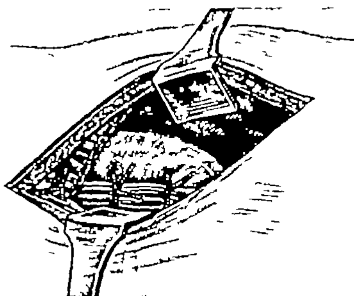


Fig. 956—Nephropexy kidney stitched to surface of quadratus lumborum. The sutures should be of stout catgut, not silk as shown.

the 12th rib the denuded area will lie upon the bare quadratus muscle The surgeon is careful to see that the upper pole is not tilted outwards and the ureter and pelvis are examined with the kidney in position to see that there is no kinking

Each end of the catgut sutures is threaded on a large curved round bodied needle The upper suture is passed through the structures at the angle of the last rib and erector spinæ muscle or sometimes is

carried through the last intercostal space and is then tied The posterior end of the second suture is passed through the quadratus muscle near its outer edge and tied to the anterior end and the ends of the lower suture are similarly treated. (*Fig 956 see also Fig 982* and Plate IX) Partial fixation of the kidney which permits a range of movement is a common source of failure the organ should be completely fixed to the posterior abdominal wall.

Should there be much oozing from the stripped surface it is advisable to place a drain on the anterior surface extending to the lower pole. This drain will lie about the middle of the lumbar wound The muscles are united with interrupted catgut sutures and the skin with a continuous suture of thread or silk The tube if used is removed in twenty-four hours The patient is kept recumbent in bed for three weeks preferably with the feet raised, and then allowed up without any abdominal support

Results.—The mortality of this operation is stated as 1 per cent but it is probably now much lower Failure may consist in the persistence of symptoms or the kidney may become loose again

NEPHRECTOMY

Nephrectomy may be performed by the lumbar the abdominal or the transthoracic route it may be extracapsular or subcapsular partial or total primary or secondary

Indications. 1 *New growths of the kidney*—All new growths of the kidney necessitate the removal of the organ if cure is to be effected In malignant growths no doubt exists of the propriety of complete nephrectomy Simple growths of the kidney comprise adenoma, papilloma of the renal pelvis and angioma. It is not possible to find and completely remove papillomata of the renal pelvis by nephrotomy and opening the urinary tract in the presence of papillomatous tissue is unsound because of the danger of seeding in the wound. Short of nephro-ureterectomy there is no method of complete cure Angiomata are very rare and give rise to serious hæmorrhage. The diagnosis of an angioma from a malignant growth is nearly always uncertain at the time of operation

2 *Renal tuberculosis*—Nephrectomy is agreed to be the best method of treatment for unilateral tuberculosis of the kidney and should be performed in all cases unless some contra indication is present

3 *Renal calculus*—Removal of the kidney is indicated in advanced cases of unilateral renal calculus where the stone is so large or branched that removal would destroy the remaining kidney tissue or early recurrence would be almost certain in unilateral renal calculus where the kidney is destroyed by obstruction (calculous hydronephrosis) or sepsis (calculous pyelonephritis or pyonephrosis) and in calculus complicated by new growth.

In bilateral cases nephrectomy should if possible be avoided If in this condition it is imperative from complications such as infection the more healthy kidney should first be relieved of its stone. Where there is advanced bilateral calculous disease operation of any kind is better avoided unless for the relief of some symptom such as severe hæmaturia or pain Nephrotomy nephrolithotomy or permanent nephrostomy would be preferred to nephrectomy

4 *Pyonephrosis* —Where the general condition of the patient is satisfactory and the second kidney is healthy primary nephrectomy should be performed. If these conditions are not fulfilled, nephrostomy followed later by nephrectomy is the best course.

5 *Pyelonephritis* —In hæmatogenous pyelonephritis causing severe hæmaturia nephrectomy may be necessary subject to the same conditions as in pyonephrosis.

6 *Hydronephrosis* —Nephrectomy is only performed where it is impossible to deal with the cause of obstruction or where the organ is completely destroyed

7 *Urinary fistulæ* following operation on the kidney or ureter

8 *Injury* —Nephrectomy may be indicated at the time or later

9 *Cysts* —Large single cysts and hydatid cysts may necessitate nephrectomy In a large single cyst free removal of the sac may suffice while in hydatid cyst marsupialization is frequently preferable Polycystic disease being almost invariably bilateral nephrectomy is seldom indicated

10 *Complications such as uncontrollable hæmorrhage during or following an operation on the kidney*

11 *Hypertension* —On the supposition that a unilateral poorly functioning ischæmic kidney manufactures a pressor substance (Based on Goldblatt s experiments)

Contra indications.—1 *Conditions affecting the diseased kidney*— Malignant growths may be widely adherent or the growth may have spread to glands or invaded surrounding structures In such cases the full extent of the growth may only be discovered during the operation experience and judgment are necessary to decide whether removal of the kidney is possible

2 *The second kidney is the seat of disease or is incapable of carrying on the renal function* —In tuberculosis and calculous disease the condition is bilateral in the late stage in a large proportion of cases Nephrectomy is then contra indicated In bilateral tuberculosis the cause of death in the great majority of cases is uræmia from destruction of renal tissue The removal of one of two tuberculous kidneys may hasten this result Exception however may exist in bilateral cases where one kidney is by all the usual methods of urological investigation functionless the seat of tuberculous destruction and therefore the source of toxic absorption whilst the other kidney is identified as diseased only by a tubercle bacilluria and shows no anatomical or physiological defect In many such cases after removal of the destroyed

kidney and with suitable antibiotic therapy cystitis has resolved and the tubercle bacilli are no longer seen in the urine.

8 *General condition of the patient* —In diseases such as pyonephrosis and pyelonephritis there may be profound toxæmia such as to contra indicate so extensive an operation as nephrectomy In such cases nephrostomy will be performed and nephrectomy carried out later

Active tuberculosis of the lungs or of bones or joints may contra indicate nephrectomy Metastatic deposits are also a contra-indication Exceptionally however removal of a large renal growth may be con sidered justified as a palliative measure even when there is evidence of secondary deposit especially in view of their radio-sensitivity

Preliminary examination —It is necessary that certain information should be in the possession of the surgeon before nephrectomy is performed e g (1) The presence and functional capacity of the second kidney (2) whether the second kidney is diseased. The usual tests for renal function and careful X ray examination of the second kidney in renal calculus should never be omitted excretion urography provides a quick and reliable means of ascertaining the state of the opposite kidney *The surgeon must also know* (3) whether the disease has spread beyond the kidney and (4) whether there are deposits elsewhere

LUMBAR NEPHRECTOMY

The curved incision already described (p 2221) is preferred for lumbar nephrectomy Where the kidney is large high and fixed it is necessary to divide the external arcuate ligament and the fibres of the serratus posticus inferior and by pulling on the rib there is no difficulty in dis- locating it upwards The steps for the exposure of the kidney have already been described (p 2221)

If the kidney is widely adherent and there is some difficulty in separating it the ureter should be exposed below the lower pole. The ureter is stripped up grasped by two pairs of curved Moynihan forceps isolated by means of gauze packing cut across just below the level of the lower pole of the kidney and touched with pure carbolic or division and cauterization may be combined by the use of the high frequency knife. The lower end is tied below the pressure forceps and dropped into the retroperitoneal plane Where primary nephrec *tomy for tuberculosis is being performed* the ureter is divided and ligated at the lowest level the wound will permit. The remains of the duct are separated as far as possible and displaced downwards into the pelvis by so doing subsequent ureterectomy if ever necessary will be simplified Treatment of the ureter in cases of tuberculosis and papilloma is further discussed on p 2390 The upper end of the ureter still in the grasp of the pressure-forceps serves as a guide for further blunt separation of the kidney and its pedicle from their surroundings In stripping up the ureter it will be remembered that as a rule the vessels of the renal pedicle lie in front of the ureter and pelvis and none of them behind these structures.

The anterior surface of the kidney is further stripped of the fatty capsule and the anterior surface of the renal pedicle exposed the veins coming first into view With the hand and dry gauze swabs the kidney is gradually separated until the upper pole is reached where its adhesion to the suprarenal capsule will be felt and may be seen

The suprarenal capsule is separated and its inner margin will be found to lie in contact with the upper and outer vessels of the renal pedicle The upper pole of a large diseased kidney may be densely adherent to the under surface of the diaphragm and in part to the liver and much difficulty may be met with in separating these dense adhesions

A fold of peritoneum lies over and is adherent to the upper part of the anterior surface of the kidney where the adhesions may be very dense. This interferes with the complete exposure of the vascular pedicle and the adhesions must be fully separated before dealing with the pedicle. Free exposure by means of an efficient kidney retractor (Fig 957) and good illumination are important at this stage Lower down the retroperitoneal surface of the colon may require careful stripping from the anterior surface of the kidney

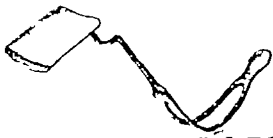


Fig 957 —Kidney retractor

Over the anterior lip of the hilum and the anterior aspect of the vascular pedicle on the right side lies the second part of the duodenum This structure may be injured during nephrectomy and in difficult cases it is best deliberately to expose it in order that it may be avoided

The kidney on its anterior and posterior aspects and at each pole having been separated attention is turned to the pedicle The pedicle

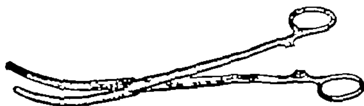


Fig. 958 —Renal Pedicle Clamp. This type is used in two sizes, a larger and heavier to grasp the deep part, a lighter size for the part of the pedicle adjacent to the kidney Division is made close to the outer clamp, see also Fig 959.

is grasped between the first and second fingers of the left hand from above downwards on the right side and from below upwards on the left side. The assistant retracts fully and prevents the peritoneum and the bowel from falling over the pedicle The pedicle is cleared by stroking with dry gauze Difficulty may arise from the matting of the tissues around the vessels with thick fibrous fat

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Lumbar Nephrectomy

The curved incision already described (p 2221) is preferred for lumbar nephrectomy Where the kidney is large high and fixed it is necessary to divide the external arcuate ligament and the fibres of the serratus posticus inferior and by pulling on the rib there is no difficulty in dislocating it upwards The steps for the exposure of the kidney have already been described (p 2221)

If the kidney is widely adherent and there is some difficulty in separating it the ureter should be exposed below the lower pole. The ureter is stripped up grasped by two pairs of curved Moynihan forceps isolated by means of gauze packing cut across just below the level of the lower pole of the kidney and touched with pure carbolic or division and cauterization may be combined by the use of the high frequency knife The lower end is tied below the pressure-forceps and dropped into the retroperitoneal plane Where primary nephrec tomy for tuberculosis is being performed the ureter is divided and ligated at the lowest level the wound will permit. The remains of the duct are separated as far as possible and displaced downwards into the pelvis by so doing subsequent ureterectomy if ever necessary will be simplified Treatment of the ureter in cases of tuberculosis and papilloma is further discussed on p 2290 The upper end of the ureter still in the grasp of the pressure forceps serves as a guide for further blunt separation of the kidney and its pedicle from their surroundings. In stripping up the ureter it will be remembered that as a rule the vessels of the renal pedicle lie in front of the ureter and pelvis and none of them behind these structures.

The anterior surface of the kidney is further stripped of the fatty capsule and the anterior surface of the renal pedicle exposed the veins coming first into view With the hand and dry gauze swabs the kidney is gradually separated until the upper pole is reached where its adhesion to the suprarenal capsule will be felt and may be seen

The suprarenal capsule is separated and its inner margin will be found to lie in contact with the upper and outer vessels of the renal pedicle The upper pole of a large diseased kidney may be densely adherent to the under surface of the diaphragm and in part to the liver and much difficulty may be met with in separating these dense adhesions

A fold of peritoneum lies over and is adherent to the upper part of the anterior surface of the kidney where the adhesions may be very dense. This interferes with the complete exposure of the vascular pedicle and the adhesions must be fully separated before dealing with the pedicle Free exposure by means of an efficient kidney retractor (Fig 957) and good illumination are important at this stage Lower down the retroperitoneal surface of the colon may require careful stripping from the anterior surface of the kidney



Fig 957 —Kidney retractor

Over the anterior lip of the hilum and the anterior aspect of the vascular pedicle on the right side lies the second part of the duodenum. This structure may be injured during nephrectomy and in difficult cases it is best deliberately to expose it in order that it may be avoided

The kidney on its anterior and posterior aspects and at each pole having been separated attention is turned to the pedicle The pedicle

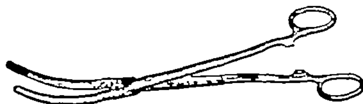


Fig. 958 —Renal Pedicle Clamp. This type is used in two sizes, a larger and heavier to grasp the deep part, a lighter size for the part of the pedicle adjacent to the kidney Division is made close to the outer clamp see also Fig 959.

is grasped between the first and second fingers of the left hand from above downwards on the right side and from below upwards on the left side. The assistant retracts fully and prevents the peritoneum and the bowel from falling over the pedicle. The pedicle is cleared by stroking with dry gauze Difficulty may arise from the matting of the tissues around the vessels with thick fibrous fat.

Large lymphatic glands to which the vessels and fat are firmly adherent make the pedicle stout and thick and when much chronic inflammation is present the whole pedicle forms a thick rigid mass. Time taken in reducing the size of the pedicle by removing adherent peritoneum thick fibrous fat and sometimes a lymphatic gland is well spent Usually the lymphatic glands are so embedded and adherent as to make their removal impossible.

A curved pedicle clamp (Fig 958) is now slipped with the blades widely open over the pedicle just to the central side of the fingers care being taken to include all the vessels if possible if some however

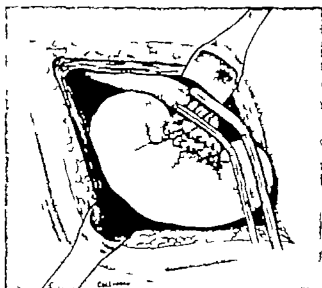


Fig. 959 —Application of Pedicle Clamps. Division of the pedicle is made close to the outer clamp in order to leave a fringe of tissue beyond the inner clamp substantial enough to give purchase for forceps placed on the great vessels. In this case nephro-ureterectomy was performed for pyonephrosis and pyo-ureter with large stones impacted at the vesical end of the duct, which is seen to be markedly dilated.

be at a distance from the main mass they must be grasped separately in powerful artery forceps On the right side the clamp will pass more easily from below on the left side from above If the pedicle is broad a second clamp may be applied from the opposite direction but usually careful work will reduce the pedicle to a size readily grasped by one clamp A lighter clamp is placed on the pedicle close to the kidney preferably as much as one inch from the former clamp to prevent when the pedicle is divided soiling of the wound with blood from the kidney or septic material from an accidentally torn pelvis. (Fig 959) The pedicle is divided close to the outer clamp leaving a broad fringe distal to the inner clamp in which the great vessels are seen and which are in turn picked up in artery forceps.

A double strand of No 2 catgut is placed round the whole pedicle deep to the inner clamp and drawn up as tightly as possible but not permanently tied A second double catgut strand is now placed mesial to the first and this is gradually and forcibly tightened as the assistant

very slowly releases the clamp When the clamp is removed this (the second) ligature should have been tightened to its utmost and the second knot tied The slack ends of the first ligature are then drawn tight and knotted The artery forceps placed on the great vessels in the fringe may now be removed assuming that the surgeon is satisfied that he has secured perfect hæmostasis and no doubt exists of the integrity of his ligatures The first ligature collects the elements of the pedicle into a bunch the clamp often keeping them rigidly spread out at the distal end. As the clamp is opened the second ligature closes up the elements of the pedicle still further and exerts full pressure on all the vessels The first ligature may be quite loose after the second has been tied These manipulations are very carefully and gently carried out without dragging on the clamp and without levering it against the edge of the wound When the clamp is removed and the ends of the ligatures are cut the pedicle will be seen fully exposed in the open wound

When the pedicle is densely infiltrated with inflammatory material so that it cannot be reduced to a size that will be safely grasped by a circular ligature it is tied in two parts. After the kidney has been removed the clamp is steadied by an assistant and a blunt pedicle-needle passed through the mass just central to the clamp being assisted by pressure of the finger on the opposite side of the pedicle

The double strand is then tied round each half of the pedicle If there is doubt of the efficiency of the ligature a second ligature may be passed in the same way The important part of the pedicle is usually in the grasp of the upper ligature

After the clearing away of clots and loose tags from the depth of the wound the muscles are brought together and the skin united

There are certain points that require further discussion

1 **Perinephric fat and vessels.**—In chronic inflammatory diseases great masses of thick fibro-fatty tissue lie round the kidney and a good deal of this will be removed during the operation In some cases the fibrosis may be so extensive as to have obliterated the perinephric space completely There is no perinephric fat and if no plane of separation can be found subcapsular nephrectomy may be inevitable

In malignant growth of the kidney all the perinephric fat should if possible be removed

In growths there may be many large veins coursing in the perinephric fat injury to which causes considerable hæmorrhage These veins are most abundant on the anterior surface and towards the lower pole Large pressure-forceps are placed on the veins but the operation should not be prolonged at this stage by meticulous care in arresting this venous bleeding as it will cease when the pedicle is controlled

2. **The ureter**—Several methods of dealing with the ureter in tuberculosis of the kidney are described (*see* under Ureterectomy p 2289)

3 **Pedicle.**—The ligature is sometimes passed through the pedicle on a pedicle-needle before removing the kidney and without using a clamp The pedicle is then ligated in two parts the strands inter locking Where the kidney is large this procedure must be carried out wholly by touch and it is in using this blind method that most of the accidents from slipping ligatures and from the non inclusion of large vessels in ligatures have occurred.

Leaving clamps on the renal pedicle was at one time a comparatively frequent method and is in very rare cases still considered necessary

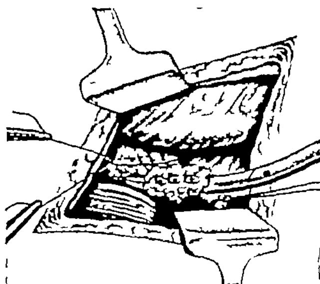


Fig 960 —Nephrectomy (right) Having cut across the vascular pedicle close to the distal clamp the fatty fringe is seen projecting beyond the proximal clamp. The first ligature shown as a single strand, is *in situ* but not tied (see text) The ureter has been ligated.

As a rule the necessity arises from incomplete exposure through too small a wound and want of care in reducing the size of the pedicle. If this method must be used the handles of each pair of forceps should be tied with thick silk to provide against the risk of their springing open. The clamps are taken off after forty-eight or seventy two hours. They should be loosened in the first instance and not actually removed until some three or four hours later A sloughing and infected wound and a tedious convalescence sometimes follow

Where the pedicle remains large and its approach owing to the presence of the large kidney renders application of the pedicle-clamp difficult or unsatisfactory a Roberts lung hilum tourniquet may be used to control the vessels while the kidney is removed The vessels may then be picked up and tied individually

4 **Drainage.**—In a few cases of nephrectomy the wound can be closed without drainage Where much oozing of blood is feared or there has been soiling of the wound with pus or tuberculous material *a rubber drain should be inserted at the upper angle* It is removed in forty-eight hours

ALTERNATIVE METHODS OF NEPHRECTOMY

1 **Gregoire's operation** —This operation* attempts to remove the kidney with its glands and the surrounding fatty and areolar tissue *en bloc* It appears however to present little if any advantage over the T shaped approach (*see* p 2220)

The incision is made vertically in the anterior axillary line from the costal margin to the iliac crest At its upper extremity it curves forwards and upwards, following the costal margin for 5 cm at its lower extremity it passes forwards along the crest of the ilium for 5 cm

The layers of the abdominal wall are incised as far as the peritoneum Posteriorly the surface of the muscles is followed separating the perinephric fascia and its contents with the fingers Anteriorly the line of reflection of the parietal peritoneum is defined and the perirenal fibrous capsule incised along this line The peritoneum and the colon are then displaced forward by blunt dissection.

The kidney is thus isolated anteriorly and posteriorly within the perinephric fascia The vessels are exposed and tied close to the vena cava and aorta and the ureter ligated and cut The kidney with surrounding fatty capsule and its lymphatics is then removed in a single mass. This operation although based on sound theoretical considerations has never been widely used by British surgeons It is now practically never carried out

2. **Subcapsular nephrectomy** —Subcapsular nephrectomy is performed in inflammatory diseases of the kidney (pyonephrosis tuberculosis) when there is such a massive firmly adherent fibro-fatty capsule that it cannot be removed

The perirenal fat is exposed and incised and the convex border of the kidney is seen The fibrous capsule of the kidney is incised longitudinally and raised on one side and the forefinger introduced between this and the renal cortex The finger is then swept over the surface of the kidney anteriorly and posteriorly and at each pole the fibrous capsule separating easily from the kidney cortex The kidney stripped of the capsule lies loose within its fibro-fatty covering The incision in this covering is extended downwards with scissors and the whole capsule laid open It is not possible owing to the rigidity of the structures at the pedicle to draw the kidney into the wound

The chief difficulty in subcapsular nephrectomy is the pedicle which is surrounded by a mass of fibro-fatty tissue. The capsule is stripped well forwards and backwards to the hilum. When this has been carried as far as possible a thick broad pedicle remains consisting of the renal vessels and the pelvis and upper ureter all covered by the reflected fatty tissue Dissection of the pedicle and upper ureter may now be carried out or may be deferred until the kidney is removed The procedure will depend on the size of the kidney and the freedom of the exposure A large kidney with a poorly-exposed hilum is

* Presse Méd., Jan. 25, 1905 xiii, 49

better treated by removal of the kidney first and dissection afterwards.

In the dissection of the pedicle an incision is made through the fibro-fatty tissue thus getting back into the extra-capsular plane of an ordinary nephrectomy and the ureter identified and followed upwards By further dissection the vascular pedicle is exposed

A powerful pedicle-clamp or lung hilum tourniquet is applied and the kidney cut away In cutting the pedicle the scissors will frequently *have to cut through kidney tissue* portions of which may be left on the stump in the grasp of the clamp If the kidney has been removed before dealing with the pedicle further dissection of the pedicle should be made A circular incision is made round the pedicle through the fibro-fatty tissue and prolonged downwards along the line of the ureter With care the renal vessels are thus exposed and the upper ureter isolated Ligatures are placed on the vessels either in a single mass or in two parts by transfixing the pedicle with a pedicle-needle If possible the ureter and remains of the pelvis should be separated from the pedicle after removing the clamp and care must be taken to cut away any portions of kidney tissue which have been left on the pedicle

If the condition of the patient admits much of the fibro-fatty tissue can be dissected away from the lower and middle areas of the wound *The wound is freely drained*

A fragment of renal tissue however small if left may be sufficient to cause a permanent fistula. Subsequent removal of such a fragment would be an operation of the utmost difficulty hence every effort must be made at the primary operation to prevent such an omission.

8 **Partial nephrectomy** —Partial nephrectomy may be employed *for injuries certain cases of tuberculosis cysts non* malignant new growths or fistulæ and may be combined with partial removal of the pelvis in certain cases of hydronephrosis (Albarran s orthopædic resection)

The first deliberate attempt to remove a portion of the kidney was made by Czerny in 1887 Goldstein and Abeshouse reviewing 296 cases of renal resection * regard the essential features of the operation as (i) the correct surgical approach (ii) careful preparation of the vascular pedicle with ligature of the vessels to the segment to be removed (iii) decapsulation in the operation area and utilization of *this portion of the capsule in closure of the wound.* (*See* Fig 967 p 2255) The portion of the kidney substance removed should be wedge-shaped so that the two cut surfaces can be applied to each other when the wound is closed by suture

The risk of hæmorrhage is considerable where the renal substance is extensively incised One of us (J E) has twice removed solitary cysts larger than lemons situated in the body of the kidneys by dissecting out their capsules which had impinged against the central calyces. In neither case was the endothermy current available and consequently fat grafts (as hæmostatic agents) from perinephric fat were placed

* *Journ. Urol., July 1937 I, xxxviii, 18.*

between the opposing surfaces of the cut kidneys as they were drawn together by mattress-sutures In two further cases J E dissected out with the endothermy knife similar large central cysts also involving calyces in one of which a calyx stone was also present Post-operative hæmorrhage was negligible in each of the four cases and all healed *per primam* without fistula formation in spite of wide openings into the calyces

Removal of the upper or lower element of a double kidney is frequent to-day It presents no especial difficulties apart from the need for precaution in analysing the vascular supply of each element with meticulous care. Overlap and interlacing of vessels may lead to confusion so that failure to recognize the precise arrangement will sacrifice the healthy element A depression or fibrous stratum may indicate the line of cleavage. Division is made in cuneiform fashion to facilitate closure of the remaining section.

Occasionally it is advisable to remove a pole generally the lower after ligation of an abnormal polar artery (*see* p 2262) a similar method is adopted

4 **Secondary nephrectomy** —Secondary nephrectomy is undertaken where one or more operations have previously been performed such as the removal of stones or where the kidney has been drained Such cases are pyonephrosis pyelonephritis and tuberculosis of the kidney with secondary infection There is usually a sinus or a fistula which is infected.

A full curved incision should be used and may follow the line of the scar or cross it. It encircles the fistula which is dissected out The scar tissue obliterates the layers of the abdominal wall. The muscles at the anterior extremity of the wound will be recognized and the wound deepened here to expose the peritoneum Care should be taken at the posterior part of the wound to avoid wounding the peritoneum which may lie far back and be firmly adherent

Here also there is a danger of cutting into the kidney which lies directly under and adherent to the posterior part of the scar When the peritoneum is recognized it is dissected forwards off the anterior surface of the kidney The lower pole is isolated and the ureter sought and dissected up Dense adhesions will be found binding the kidney to the lower rib margin and the peritoneum may inadvertently be opened in cutting through this layer

Posteriorly the kidney is adherent to the quadratus and psoas muscles and care should be taken not to strip up a layer of these muscles with the kidney At the upper and anterior aspects the kidney is as a rule less densely adherent and a good vascular pedicle is usually obtained

The steps of the operation follow the lines already laid down.

It may be found at the early part of the operation that removal of the kidney with its capsule is not possible and a subcapsular nephrectomy must be performed

Not infrequently an operation which is partly intracapsular and partly extracapsular will result

5 **Transperitoneal nephrectomy** —The two conditions under which the transperitoneal route is indicated are (1) injuries to the kidney where it is suspected that other abdominal viscera are involved (2) large growths of the kidney

For the latter the curved lumbar incision with the transverse extension (p 2221) or the upward extension in the midline (p 2223) gives all the advantages of a transperitoneal operation with the exception of ligation of the main vessels as an early step before manipulation and mobilization of the kidney Those in favour of the transperitoneal operation stress the value of early vascular control as a protection against operative dissemination.

The incision may be placed in the middle line or be paramedian. In very large growths the paramedian incision is preferable. The intestines are packed off and the parietal peritoneum is incised along the outer border of the colon and several centimetres from it The colon is displaced inwards exposing the anterior aspect of the kidney and the renal pedicle

The ureter and vascular pedicle are exposed by further dissection The ureter is clamped and ligated and the vascular pedicle isolated clamped ligated in two segments and cut across The extirpation of the kidney proceeds partly by blunt dissection and partly by clamp and ligation of vascular adhesions. Care is taken to remove all the perirenal fat in which the renal lymphatics lie. Any abnormally enlarged glands are removed by dissection.

A stab-incision is made through the muscles of the loin and a drainage-tube introduced The colon is replaced and as far as possible the peritoneum repaired Rutherford Morison originally favoured a T-shaped incision. The abdomen was opened vertically in the linea semilunaris and a second incision was carried transversely backwards in the ileo-costal space towards the loin When the introduction of the cystoscope removed the need for manual examination of the other kidney he discontinued the vertical section and only retained the transverse part An incision of this type may have advantages in the removal of the largest renal neoplasms especially where extensive adhesions are suspected and perinephric tissue is also to be removed

6 **Thoraco-abdominal nephrectomy** —The patient is placed in the usual position and intra tracheal anæsthesia is used. Beginning near the spine the incision usually follows the line of the 10th rib and is continued in the same line on to the abdomen as far as the lateral border of the rectus. The rib is resected subperiosteally as far back as possible and the pleural cavity is opened. The chest incision is continued across the abdomen to the rectus muscle Any adhesions between the layers of the pleura are separated by sharp dissection and the wound is held open by a rib retractor If it is considered advisable, diaphragmatic movements can be eliminated by crushing the phrenic

nerve or infiltrating it with local anæsthetic. The diaphragm is then incised in the line of the wound taking care not to injure the underlying liver or spleen. The renal mass usually bulges up into the wound and is retracted laterally whilst the duodenum or colon is gently separated from its anterior surface. The renal pedicle can then be easily exposed clamped and divided. Next the ureter is divided and ligated and the kidney with the surrounding perirenal fat removed *en bloc* The peritoneum is closed and the renal bed drained through a stab incision in the loin Next the diaphragm is repaired with interrupted catgut suture and then the pleural cavity drained through an interspace above the incision with a White s catheter A few cubic centimetres of Proctocaine is injected into the 9th 10th and 11th intercostal nerves and after forcibly re-expanding the lung the chest is carefully closed with interrupted catgut sutures. The peritoneum and abdominal muscles are sutured and finally the skin The intercostal drain is clamped until the patient reaches the ward when underwater drainage is substituted Some surgeons do not drain the pleural cavity but rely on repeated post-operative aspirations This approach to the kidney has been increasingly used during the last few years and is a good approach in cases with a large renal tumour because it gives easy and adequate access to the renal vein without much manipulation of the tumour

Difficulties and dangers of nephrectomy—1 Difficulties incidental to the type of patient and the character of the disease are frequently encountered

The patient may be stout and the ilio-costal space narrow Widespread adhesions may require prolonged and careful dissection. A voluminous gas-distended colon sometimes fills up the wound and is more troublesome if the anæsthesia is incomplete or if the anæsthetic is difficult to administer

The vascular pedicle may be naturally short and may in addition be thick and rigid from inflammatory infiltration and enlarged glands

2. **Hæmorrhage.**—Venous hæmorrhage may arise from the large veins covering a malignant growth The ovarian or spermatic veins lie in close relation to the ureter They should be isolated and if necessary ligated. These veins sometimes give rise to difficulty in ligating a short renal pedicle and full exposure and ligation below the kidney before dealing with the vascular pedicle may save much trouble later Arterial hæmorrhage may result from the tearing of an aberrant artery It is only likely to cause difficulty at the upper pole and with moderate care this accident is easily avoided

Hæmorrhage from the renal pedicle is usually due to failure to include all the vessels in the ligature or to slipping of the ligature. Such accidents as tearing the kidney off the vascular pedicle are due to want of judgment in placing too great tension on the kidney to undue haste or to carelessness

The preparation and method of ligature of the pedicle is the most important part of the operation of nephrectomy and neither time nor trouble should be spared in carrying it out.

Tearing of the inferior vena cava is followed by the welling up of dark venous blood in the wound It is readily controlled by digital pressure and after clearing away the blood the torn portion is picked up in forceps and sutured with fine catgut. If the hole cannot be satisfactorily ligated or sutured a pressure clamp may be left on it must not be removed sooner than the third day after operation The after history of such cases is satisfactory

Hæmorrhage after the operation may be due to faulty application of the pedicle ligature or to sepsis Both are very rare the latter *occurring most frequently in traumatic cases*

3 **Injury to the pleura.**—This is shown by the whistling of air at each respiration It is more likely to occur where the 12th rib is rudimentary or where the rib is removed (*See* p 2223)

4. **Injury to the bowel**—In separating the colon from the kidney dense adhesions or a localized abscess may be found and tearing of the bowel has been described Sloughing of a portion of the bowel previously involved in the perinephric inflammation may follow operation In such cases the fistula closes as the wound granulates and operations to close the opening should not be attempted unless a permanent fistula has formed

Mayo describes injury to the second part of the duodenum by the pedicle-clamp in right-sided nephrectomy He recommends an abdominal operation for the closure of the fistula. If such an injury is detected at the time it must be repaired by suture

5 **Shock.**—Profound shock due to the length of the operation to dragging on the sympathetic nerves related to the renal pedicle and *to loss of blood may result from nephrectomy and may be present at* the end of the operation or may become acute three or four hours after the patient is returned to bed

At the end of a long operation the cavity from which the kidney has been removed may be filled with hot saline solution before the wound is closed The usual remedies for post-operative shock are adopted

6 **Distension of the stomach or the colon.**—These are frequent and troublesome complications after kidney operations and especially after nephrectomy After operation an early action of the bowel should be ensured by castor oil followed by olive oil enema if necessary Saline aperients should be avoided. Gastric dilatation will require lavage.

7 **Uræmia.**—Uræmia was at one time the most frequently fatal post-operative complication of nephrectomy It is very rare in urinary surgery at the present day as the result of early diagnosis of renal disease and the more careful selection of cases for nephrectomy which is possible by modern methods of pre-operative examination.

General Survey of Results of Nephrectomy

Whilst mortality provides the item of primary statistical interest and considerations of operative results seldom go beyond it with the exception of nephrectomy for cancer and tuberculosis the state of persons with only one kidney recognized of importance by Ellis and Weiss* has to be considered as well Hanley† in a study of 218 nephrectomized patients was able to trace 182 for periods up to six years. His findings may be briefly summarized —

	Mortality		State in survivors traced	
	Operative	*Total* (up to 6 yrs.)	*No*	
Hydronephrosis (40 cases)	5%	10%	29	50% showed R F sub-normal. Many c/o contra lateral pain and pelvic dilatation shown
Pyonephrosis (44 cases)	20%	34	24	38% showed R.F sub-normal 12% renal failure Contra lateral pain and pelvic dilatation in 50%
Calculous pyonephrosis (49 cases)	6 1%	16.3%	40	75% showed R.F sub-normal.
Tuberculosis (48 cases)	4 1%	22.9% (with 6 yrs)	31	33% cystitis lasting 3 yrs. 33% non-renal tuberculosis. Over 30% retained T B in urine and a further 20% B.C.C. cystitis. 54% showed R.F sub-normal.
Neoplasms (77 cases)	22%	63% (within 2 yrs.)	8	R.F good.

R F = Renal Function

Ellis and Weiss found a lower incidence of depressed renal function their result being 41 6 as compared to the 56 per cent. of Hanley The last adopted the usual tests (estimations of blood urea and non protein nitrogen MacLean s urea-concentration test and Van Slyke s urea-clearance test) most reliance was placed in the clearance test

Compensatory hypertrophy.—Insufficient data are as yet available by which this may be reckoned Contra lateral pain may be some evidence that the surviving kidney is working to the full. Radiographic enlargement of renal outline and it seems some dilatation of the renal pelvis is common but no reasonable explanation of the last phenomena is so far to be found According to these means of assessing hypertrophy age bears no influence animal experiments however have proved the reverse that hypertrophy is active in the young and meagre in old animals.

Results of nephrectomy i **Mortality**.—The operative risk of *lumbar nephrectomy* will vary proportionately to the size and fixation of the kidney and the constitutional state of the patient In favourable cases an immediate mortality of no higher than 2 5 per cent is to be expected. Adverse factors may raise the mortality rate to over 20 per cent For the high mortality of war wounds associated injuries are in the main responsible

* *Amer Journ. Med. Sci.*, 1933, clxxxvi, 2, 242.
† *Brit. Journ. Surg.*, 1940, xxvii, 107 [illegible]

In nephrectomy for calculi infection is a governing factor Rafin surveying the results of eight surgeons found no mortality in 25 cases for uninfected calculi but 7 5 per cent in 155 infected cases many of which it may be assumed were adherent pyonephroses.

The immediate mortality of nephrectomy for *renal tuberculosis* was found to be 4 per cent.* such deaths as occur having generally been ascribed to the tuberculosis rather than to the trauma of operation *A follow-up of 369 nephrectomized patients (German Urological* Congress 1911) showed 15 2 per cent to have died in the subsequent 16 years 10 6 per cent having died in the first two post-operative years More recent statistics offer a no more optimistic outlook indeed in cases traced over a period of five years it appears that a recovery rate better than 60 per cent cannot reasonably be expected. Possibly now that nephro-ureterectomy is being more systematically adopted future statistics will be more favourable. The more radical operation seems to add little to the immediate risk and in a personal series by one of us (J E) of 24 nephro-ureterectomies (now considerably increased) there was no operative mortality † A series of 50 neph*rectomies for tuberculosis also showed no immediate mortality* Swift Joly‡ in a review of results obtained by surgical treatment stated that the immediate mortality was 5 per cent. the late mortality 15 to 20 per cent and permanent cure 50 per cent

In **renal neoplasm** immediate mortality mirrors the progress of major surgery through the last half century apparent retrogression indicated in the more recent figures may be ascribed to more accurate *assessment and greater boldness in the attack upon cancer* Thomson-Walker § tracing the decline in mortality gives the following interesting comparisons —

1885	Minges	*85 per cent.*
1888	Tuffier	*65*
1902	Albarran and Imbert	22 for connective tissue tumours and 15 to 20 per cent for tumours of the pelvis

Schmieden s|| personal review of 329 cases shows comparable results

In the first ten years of renal surgery	mortality of 64 8 per cent
second	48
third	22

Transperitoneal nephrectomy *before 1890* showed a higher mortality than lumbar (50 as compared with 37 per cent.) the difference being mainly due to septic complications since that date however the figures are reversed death rate from the lumbar operation being

* Thomson-Walker, *Brit Med. Journ.*, October 1927 ii, 625.
† *Proc. Roy Soc of Med.*, 1940, xxxiii, 395.
‡ *Lancet*, Nov 17 1934, 1119
§ "Genito-Urinary Surgery", Cassell & Co., 1914, 1st Ed p. 202.
|| *Deuts Zeitschr. f Chir* 1902, lxiii, 203.

greater in the proportion of 28 to 21 1 per cent according to Albarran and Imbert * Trendelenburg and Riedel who both employed the transperitoneal route claimed even better results 20 and 11 1 per cent respectively H G Hanley† found the post-operative mortality in 27 cases of neoplasm patients of different surgeons was 22 2 per cent.

In a recent review of 940 cases Riches and others‡ reported a mortality after lumbar nephrectomy of 4 per cent in 167 cases treated by transperitoneal nephrectomy the mortality was 5 per cent Involvement of the vena cava directly affected the immediate post-operative mortality in 225 cases in which the vein was involved the mortality was 18 per cent.

Nephrectomy for *adeno-sarcomata* (Wilms tumours) shows a high operative mortality 25 to 30 per cent

ii. **Ultimate results.—Incidence of recurrence**—*Tumours of the Parenchyma in Adults* Thomson Walker (*ibid*) and Legueu§ agree that recurrence is found in 60 per cent of those who recover from the operation the majority (70 per cent) showing metastases in the first year the incidence of relapse diminishes with each succeeding year Israel ‖ reviewing his results to 1909 recalls that of his 124 nephrectomies for malignant neoplasm the operative mortality was 22 2 per cent 82 6 per cent of the survivors (that is 27 7 per cent. of the original 124 cases) were free of recurrence after three years and 85 9 per cent. of these (namely 25 per cent of the total) could be regarded as cured since they showed no sign of recurrence after five years Voelcker in 1920¶ shows very similar results J T Priestley ** reporting results from 1910 to 1936 states that of the 482 survivors of the 568 operated for renal growths (*a*) with hypernephromata 47 7 per cent. had lived three years 38 4 per cent five years and 27 8 per cent. ten or more years and (*b*) with epitheliomata the figures were almost the same except beyond the ten year span. Bull†† gave details of 24 survivors of nephrectomy for hypernephroma 11 have lived more than 8 years 5 are alive without recurrence 18 12 8 8 and 8½ years 8 died from recurrence 6¾ 4 and 4 years after operation 1 is alive with recurrence 12 years after operation and 2 died from other causes 7 and 4½ years post-operatively Of 685 cases reviewed by Riches and others‡‡ the survival rate for one year was 80 per cent. that for three years 44 per cent that for five years 30 per cent. and after ten years only 17 per cent remained alive.

Wilms tumours—G Neumeyer§§ reported 7 operated cases in every one of which there was death from recurrence within five months Of 756 recorded, only 17 lived 5 years after operation In a personal

* *Les Tumeurs du Rein*, Paris, 1903.
† *Brit. Journ. Surg.* 1940, xxvii, 107 853.
‡ *Brit Journ. Urol.*, 1951 xxiii, 318.
§ *Traité Chir d'Urol.*, 2nd Ed., 1921 p. 1149
‖ *Chir der Niere und des Harnleiters*, 1925, p. 454
¶ *Die Krankheiten der Niere in Kraus und Brugsch.* Bd. 7
** *Journ. Amer. Med. Assoc.*, 1939 cxiii, 902.
†† *Klinische Erfaringer Om Hypernephroma*, 1913–1933, Oslo, 1935.
‡‡ *Brit. Journ. Urol.*, 1951 xxiii, 318
§§ *Zentralbl. f. Chir* 1930 lvi, 1230.

case a female child aged 14 months from whom one of us (J E) removed an adenosarcoma of the left kidney 4½ in. in diameter died 10 years later from osteomyelitis of the tibia a full autopsy gave no evidence of recurrence or metastases In reviewing 188 cases Riches and others reported that roughly 50 per cent. survived one year after nephrectomy alone and 30 per cent five years Thirty three per cent. survived one year after nephrectomy and post-operative X rays and 20 per cent. survived five years but the numbers in this series are small. Denning* reviewed all cases of renal tumour in the New Haven Hospital over the preceding twenty years 19 5 per cent were alive at the end of five years 14 6 per cent. at the end of ten years and only 9 08 per cent. after the ten year period.

NEPHROLITHOTOMY

In nephrolithotomy one or more calculi are removed from the kidney by cutting through the renal parenchyma.

Preliminary investigation.—Certain information must be in the possession of the surgeon before he embarks on the operation.

1 *The calculus.*—The X ray shadow must not only be proved a renal calculus by its radiographic characters its position must be accurately localized by the relation it bears to the pelvis and calyces shown by pyelography Non-opaque calculi may produce a filling defect of the renal pelvis or blot out a calyx such calculi may retain a coating of urographic medium for a short while after its introduction and so reveal themselves It is our custom to order a radiographic examination on the day of operation on account of the elusiveness of smaller calculi.

2. *The affected kidney*—Palpation may demonstrate enlargement where there is hydronephrosis pyonephrosis or massive perinephritis. Excretion urography will show anatomical and physiological defects by comparison with the healthy side. A localized renal hydronephrosis caused by obstruction of a calyx by a calculus should be noted. Cystoscopic observation of the character of effluxes from the affected kidney especially if coloured by a preliminary intravenous injection of indigo-carmine and collection of the two kidney urines for comparison of urea percentages as well as of pathological contents will reinforce clinical and radiological observation.

Indications for nephrolithotomy—This operation is performed with reluctance by urological surgeons of experience on account of the not inconsiderable risk of late hæmorrhage. The tendency to-day is to refrain from removal of the smaller calculi embedded in calyces where radiography appears to show little prospect that the calculi can be grasped from and withdrawn through the pelvis. Such calculi are often silent stones causing no pain and no pathological changes within the kidney and operative removal may cause more renal

* *Journ Urol., 1944, lv 571.*

damage than the stones ever will But when there is pain recurring hæmaturia localized hydronephrosis (shown by excretion urography) casts and pus in the urine collected by ureteric catheter nephrolithotomy may be required. A branched calculus which has not caused renal destruction severe enough to indicate nephrectomy or one present in a single functioning kidney is generally removed by nephrolithotomy or by methods such as those described by Marion (p 2256) Calculi in the pelvis of a pyonephrotic kidney are occasionally removed by nephrolithotomy the opening thus made being better adapted for nephrostomy a more suitable method for sustained drainage than pyelostomy being in this way established (see p 2259)

Technique—The kidney is exposed by a curved lumbar incision (p 2221) and is mobilized. It is important before incising the kidney to free it from its attachments and draw it as far as possible into the wound to facilitate control of the vascular pedicle The kidney and renal pelvis are carefully palpated and the stone may at once be felt. If in the pelvis pyelolithotomy will be carried out. If it is felt in the kidney and cannot be manipulated into the pelvis the pedicle is grasped near the hilum between the forefinger and thumb of the left hand and an incision made in the renal cortex just posterior to the most prominent line of the convex border is deepened on to the stone over which the knife is felt to grate. The length of the incision depends upon the previously ascertained size of the stone

Fine long dissecting forceps or Thomson Walker s stone-forceps

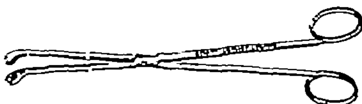


Fig 961 —Thomson-Walker s renal stone-forceps.

(Fig 961) are introduced into the wound and the blades manœuvred round the stone which is grasped and gently extracted Great care must be taken to avoid crushing or breaking the stone as even a small piece chipped off and left behind may form the nucleus of a new calculus A scoop or the forefinger of the right hand may be required to loosen the stone from its bed It should be examined for facets or fracture indicating that other stones or fragments have still to be removed The stone should be compared with the X ray film and if there is any discrepancy between the shadow and the size and shape of the stone a renewed search in the calyx and pelvis must be made

Several stones may be present and an extension of the incision may be necessary or other incisions may have to be made If a stone is felt near the surface on the anterior or posterior aspect of the kidney an incision is made directly over it radiating from the hilum On the whole however the incisions that give best access are those made on

the convex border Where the stones are multiple careful study of the X ray film and repeated search in the calyces and renal pelvis with the finger and with the probe are necessary before concluding that all have been removed

A ureteric bougie may be passed through the pelvis and down the ureter in search of small obstructing calculi but with modern X ray work and the passage of ureteric catheters before operation this is

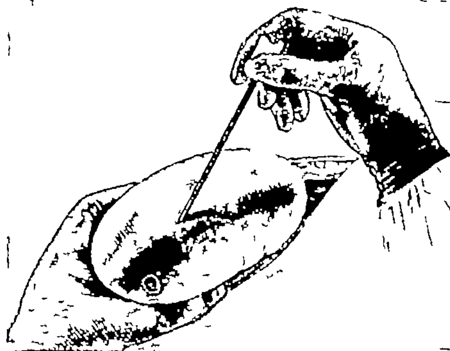


Fig 962.—Nephrolithotomy exploration with grooved probe.

rarely necessary If residual fragments are suspected or sepsis is present the calyces and pelvis should be washed out with a stream of saline before closing the incision in the kidney

When a small stone shadow has been seen with X rays and is not felt on palpation the kidney is held between the fingers and thumb of the left hand and the blunt end of a fine straight needle or a grooved steel probe is pushed through the capsule in the line of the convex border and at the level at which the shadow is shown in the film (Fig 962) The instrument is pushed on into the renal pelvis and if nothing is felt another spot over a calyx is probed This method if systematically used usually reveals even a small calculus if however it does fail a probe may be passed up into the calyces through a small opening made in the renal pelvis and in this way the various culs-de-sac may be sounded A combination of these two methods seldom fails to find the stone When the probe is felt to grate against the calculus it is held by an assistant and the knife slid along the groove

down to the calculus (Fig 963) The fine stone forceps follow and the stone is removed through a very small opening with a minimum amount of destruction of kidney tissue (Fig 964) One or at most

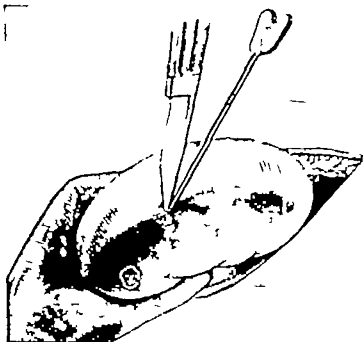


Fig. 963.—Nephrolithotomy incision on to stone along grooved probe

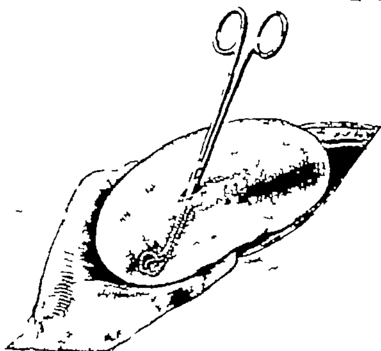


Fig 964 —Nephrolithotomy removal of stone.

two interrupted sutures and a single mattress-suture will suffice to close the wound if closure be considered desirable. Many notably

Cabot and Marion hold that complete closure aggravates the tendency to late hæmorrhage and they prefer therefore always to drain the calyx by a tube the deep end of which lies in the pelvis for two or three days to ensure absence of tension upon the kidney substance from a retained collection of blood This is especially advisable in the presence of sepsis or where trauma has been unavoidable

Where a calculus has eluded search after incision of the kidney it may be necessary to introduce a finger through an incision in the posterior wall of the pelvis and then continue the search with one forefinger in the pelvis and the other through the nephrotomy wound In other cases the pyelotomy has first been performed and a nephrotomy is done to extend the exploration Radiography of the kidney (fluoroscopy) during operation for stone first suggested by Hurry Fenwick has been developed at the Mayo Clinic and is of use in searching for small stones that have eluded the finger and probe of the surgeon or in displaying fragments left behind after removal of a calculus The method consists in screening the kidney raised up on the loin or placing a small film suitably protected in the depth of the wound when the kidney cannot be raised up to the surface The method involves special X ray apparatus and an expert screener whose eyes are dark-adapted by suitable spectacles. The operating surgeon would have little prospect of recognizing minute shadows on a fluorescent screen in the operating theatre. A portable radiograph *can be taken on the table in cases of doubt* On the whole radiography at the time of operation has proved to be of very limited value.

Where dilatation of the calyces and pelvis is present in varying degrees *of pyonephrosis every pocket must be searched* for stone the kidney thoroughly washed out with saline a drainage tube inserted through a dilated calyx and into the pelvis and the kidney so drained *for at least a week Daily irrigation of the pelvis is carried out* through the tube or continuous drip irrigation established, a counter-opening being made in another of the dilated calyces into which a tube is tightly sutured. *In this way the whole kidney is kept thoroughly* flushed out and we have on several occasions kept such a system working for a fortnight Suby* has suggested the use of his Solution G to wash out the calyces. *The pH is so adjusted that it will dissolve the* calcium salts slowly without injury to the living tissues. Others, however have found the results disappointing

Dangers and complications.—The dangers include those of any kidney operation and have already been described (p 2241) but *bleeding requires especial emphasis*

Hæmorrhage is the danger especially associated with nephrolithotomy It may occur during or after the operation With digital control of the renal pedicle the operation may have proceeded *smoothly* until after the kidney sutures have been applied when it may be

* *Proc Roy Soc. of Med.*, 1944, xxxvii, 608.

found that the hæmorrhage continues and quickly distends the pelvis The introduction of additional mattress-sutures may be sufficient to control the bleeding but it may be necessary to remove the kidney Postoperative hæmorrhage may escape from the drainage-tube or pass down the ureter or it may collect in the perirenal space if this is badly drained The hæmorrhage may become serious the day after operation and in this case is due to incomplete control of the vessels by the sutures It may occur four or five days or as late as ten days after the operation. Makkas described 10 cases of postoperative hæmorrhage of secondary type in 8 the hæmorrhage occurred on the eighth day in 2 on the

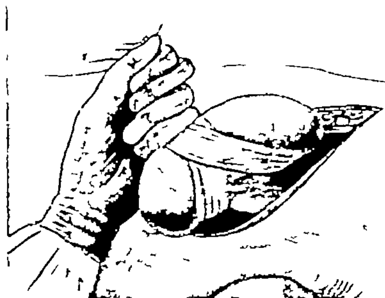


Fig 965.—Exploration of renal pelvis method of holding kidney

seventh and in 1 on the ninth If the temperature is raised the hæmorrhage is due to swelling and softening of the kidney tissue from inflammation which leads to tearing out of the ligatures (Marion) In aseptic cases late hæmorrhage is due to the sutures giving way about the tenth day

The conditions likely to cause postoperative hæmorrhage are (1) Imperfect control of the vessels (2) Tying the sutures in the kidney too tightly so that they cut out (3) Stripping the capsule so that the sutures do not hold (4) Sepsis imperfectly drained (5) Early absorption of the sutures (6) Tension upon renal tissue from a hæmatoma or retained products of sepsis.

Postoperative hæmorrhage should be carefully watched by taking note of the amount of hæmaturia the local condition of the operation area and the general state of the patient Increasing pallor an unsatisfactory blood picture and a falling blood pressure call for prompt action it is customary to-day to resort to blood transfusion before alarming effects arise Happily this will often stop bleeding but if it does not do so quickly no time must be lost in exploring the

kidney Hæmorrhage may be controlled by opening the kidney and packing it with gauze but in the majority of cases where the hæmorrhage is severe a rapid nephrectomy is the best treatment Nicolich found nephrectomy for postoperative hæmorrhage necessary in 4 out of 86 nephrotomies

Pyelolithotomy

Pyelolithotomy is the removal of a calculus through an incision in the renal pelvis

To carry out this operation certain conditions are necessary The stone must be of moderate size—neither very small nor very large—and situated in the pelvis, in the upper end of the ureter or in a calyx or calyces accessible from the pelvis. A rigid short pedicle and a narrow thick loin will make the operation difficult and may render it impossible.

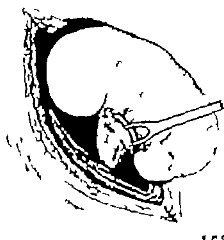


Fig 966 – Right Pyelolithotomy A transverse opening is made in the pelvis to avoid the possibility of dividing the posterior branch of the renal artery (held aside by a retractor) and of encroaching on the uretero-pelvic junction.

Technique.—The kidney is exposed and drawn out into the wound and is turned upwards and forwards to display as fully as possible the posterior aspect of the pelvis. It is then held in position by the assistant with the aid of gauze slings under each pole (Fig 965) Care must be taken to avoid too powerful traction on the slings as the atrophied pelvic wall may rupture at the site of stone impaction (*see* p 2254)

The kidney having been drawn up and rolled over a coating of fibrous fat will be found adherent to the posterior surface of the pelvis. This is incised at the lower part of the pelvis and reflected upwards exposing the muscular wall. With the opposite index finger exerting counter pressure an incision is made in this wall in the *long* or transverse axis of the pelvis when the knife will grate against the stone. Fine forceps or a scoop are introduced and the stone carefully removed

On account of two possible dangers of this operation, hæmorrhage and stricture at the uretero-pelvic junction one of us (J E) *prefers* a transverse incision parallel to the long axis of the kidney as avoiding these possibilities (Fig 966) Hæmorrhage arises from division of the posterior branch of the renal artery which runs transversely on the posterior aspect of the pelvis often hidden by the posterior lip of the hilum. A vertical incision if continued too high, may involve the

vessel ligation of which may be difficult A stricture results from carrying a vertical incision too near the pelvic outlet The dangers of a vertical pyelotomy are necessarily greater when the kidney cannot be delivered and the operation has to be performed in the depth of the wound Winsbury White recommends a longitudinal incision along the lower concave border of the renal pelvis

A stout pliable probe bent almost at a right angle is used to sound the pelvis and each of the calyces for other stones The finger may also be introduced into the pelvis A ureteral bougie is passed down the ureter into the bladder to ascertain if obstruction from stone or stricture is present The edges of the wound in the renal pelvis are picked up with long fine forceps and brought together with stitches of fine catgut each stitch taking the muscular coat and avoiding as far as possible penetration of the mucous membrane A continuous stitch of fine catgut may be used, but we prefer a minimum number of interrupted sutures not too closely placed as these are less likely to interfere with the vascularity of the edges

The flap of fat is now replaced over the wound and held by a stitch The slings are removed and the kidney returned to its bed A drainage-tube is inserted with the terminal opening in the neighbourhood of the wound in the renal pelvis so as to provide a track to the surface for any urine that may escape.

Occasionally a stone located by pyelography as in the pelvis is found at operation to have escaped into a calyx from which it can generally be removed with a narrow scoop A pair of stone-removing forceps made with a bend of more than a right angle are most useful for removing a stone situated in the lower calyx If the kidney after separation be gently squeezed the stone can sometimes be returned into the pelvis so that by these methods the more damaging operation of nephrolithotomy may be avoided

When the kidney cannot be delivered into the wound the operation may still be carried out if the stone is of moderate size In such a case the kidney is grasped in the left hand with the fingers in front of the pedicle and the thumb on the posterior surface of the pelvis By pressure with the fingers the pelvis is made prominent under the thumb and the stone can be felt Without actually seeing the posterior wall of the pelvis a scalpel may be passed behind the kidney and a small incision made over the stone and this is enlarged by long bladed dissecting forceps and the stone removed No stitching of the wound in the pelvis is possible so that especial care must be taken when the kidney is replaced to lay the end of the drain close to the opening in the pelvic wall to prevent accumulation of urine outside the pelvis When the pelvis has been stitched the tube should be retained for four days There is usually no leakage of urine and on removal of the tube the track at once heals. When no stitches have been introduced, drainage may be free for five or six days and will then begin to diminish in this case the tube is gradually shortened and may be removed about a week after the operation.

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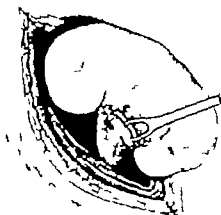


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The flap of fat is now replaced over the wound and held by a stitch The slings are removed and the kidney returned to its bed A drainage-tube is inserted with the terminal opening in the neighbourhood of the wound in the renal pelvis so as to provide a track to the surface for any urine that may escape.

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Dangers and sequelæ. 1 Rupture of the pelvis.—The wall of the pelvis may have been so thinned that traction on the kidney or even the mere weight of the kidney may be sufficient to break it away from the ureter This was the experience in one of our cases (J E.) End to-end suturing with drainage of the renal pelvis through a nephrostomy incision was successful a ureteric catheter was used as an internal splint, its distal end being passed down the ureter and its proximal carried through the nephrostomy wound and attached to skin alongside the nephrostomy tube. Its presence as a guide facilitated the pelvi ureteral suturing Primary union took place as shown by the absence of a urinary fistula.

2. Hæmorrhage from the posterior branch of the renal artery should not occur if the kidney has been easily delivered and the adherent fat properly separated from the posterior surface of the pelvis. If the artery is divided under the lip of the hilum artery forceps cannot grasp the bleeding points The procedure then is to under-sew some distance on either side of where the vessel was divided taking up in the stitches an adequate amount of pelvic wall and the lip of the hilum

3 Perinephric extravasation of urine.—If the area behind the pelvis is not drained or is imperfectly drained and urine leaks it may accumulate outside the pelvis in the perinephric cellular and fatty tissues and certain symptoms arise. Hiccough commences at first at intervals and later becomes constant it is distressing and if continued becomes exhausting There is distension of the colon and occasionally nausea and vomiting The temperature is not raised unless the urine is septic. After several days urine usually discharges from the wound and the symptoms at once subside, but if the pain and pyrexia continue reopening the wound and establishment of free drainage should not be delayed. There is delay in healing and a fistula may form

4 Fistula.—Fistula after pyelolithotomy is due to (1) obstruction at the ureteropelvic junction or in the ureter from an overlooked calculus or stricture (2) sepsis (3) lack of drainage. The last is the most frequent cause. If urine is allowed to accumulate outside the pelvis a cavity with rigid walls is formed and into this the pelvic wound opens. The urine gradually finds its way to the surface and a track with thick fibrous walls is created and becomes a urinary fistula. The frequency with which fistula follows pyelolithotomy has been over stated The danger is avoided by examining for and removing obstruction clearing up sepsis and carefully placing a drainage-tube in relation to the pelvic wound In 15 cases of pyelotomy recorded by Marion 8 were not sutured and recovered rapidly 7 were sutured and 5 of these recovered without escape of urine 1 had a fistula for three weeks and 1 a permanent fistula. Bazy sutured the pelvic wound in 11 out of 16 cases and in 5 for various reasons he could not suture it In the 11 sutured cases 9 recovered very rapidly and without incident. In the 5 unsutured cases 1 had no escape of urine

1 had a fistula for thirty days although the urine was aseptic in 1 there was a discharge of urine for several days and in the remaining 2 the recovery was uneventful

5 Stricture of the ureteropelvic junction may follow removal of a large stone through too long a vertical incision encroaching upon the ureteropelvic junction A stricture will require periodic dilatation (cystoscopic) or plastic surgery (p 2265)

Calicectomy (Fig 967)

Engel* recommends this operation in cases with a stone in a dilated calyx especially if the calyx is the upper or lower one Flaps of capsule are reflected and a wedge of renal tissue excised to include the affected calyx after temporarily controlling the renal pedicle The kidney is repaired with mattress sutures through the capsule. No recurrence occurred in 9 cases operated on by Engel and followed for 5 to 12 years This operation is widely used in the U S A and is becoming increasingly popular in this country



Fig. 967—Diagram illustrating the operation of calicectomy

Operations for Pelvi Renal Calculi

Proof of the greater safety of pyelolithotomy having been established (*see* p 2257) a calculus should be removed by this means if possible with very few exceptions A stone lying in a calyx may have its base close enough to the pelvis to allow some part of it to be grasped by forceps or caught in a scoop through a pelvic opening Sometimes the neck of the calyx may be stretched with narrow bladed angular forceps and the stone coaxed out. Gentle squeezing of the whole kidney may expel a stone into the pelvis as already mentioned (p 2258)

But the problem which sometimes must be faced is how to attack a pelvi renal branched calculus perhaps in a single kidney the other having been removed previously for stones or destroyed by them The danger of hæmorrhage after nephrolithotomy is so real that the surgeon may shrink from taking the risk. In one such case with the aid of a Gigli saw one of us (J E)† was able to fragment and remove a large branched (stag horn) calculus in a single functioning kidney without encroaching upon the parenchyma. The pelvis was incised over the stone and the lips of the incision were retracted sufficiently to allow the eyed end of a probe fashioned like an aneurysm

* *Journ Urol* 1947, lviii, 419
† *Proc Roy Soc of Med* March, 1935, xxviii, 1127

needle to be insinuated around the body of the stone. The stoutest silkworm gut was threaded on the probe and the probe withdrawn A Gigli saw was then attached to the silkworm gut and carried round the stone which was cut through easily A second cut was similarly made and the fragments of the stone withdrawn without difficulty Recovery was uninterrupted (Fig 968) In some cases the operation for removing a branched calculus may be one of extreme difficulty because the whole of the pelvis of the kidney is intrarenal

Marion* describes a limited parenchymal incision (Pyelotomy

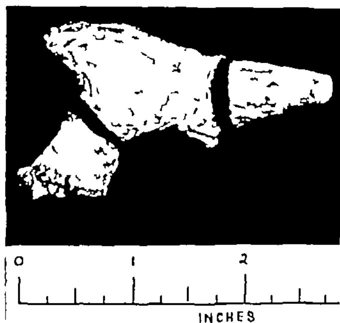


Fig. 968 —Stag horn calculus (reconstructed) removed from a solitary kidney through a pelvic incision. The stone was trisected by a Gigli saw introduced through the pelvis the lines of the cuts are seen. Actual size. Weight 29 gms.

élargie) continued from the pelvic incision and carried through the lip of the hilum as far as necessary to remove the stone The retro-pelvic artery will probably need ligating Babics† describes posterior pyelostomy for removing large stones The pelvis of the kidney is only loosely connected to the neighbouring parenchyma, and by dissecting in the interval between the parenchyma and pelvis the pelvis and calyces can be displayed. If the parenchyma is retracted by a blunt hook the necks of the calyces can be seen. The dorsal *branch of the renal artery must be preserved.* The necks of the calyces are easily torn. The danger of this operation is severe and uncontrollable hæmorrhage from the vein which runs longitudinally deep in the interval between the renal pelvis and the parenchyma of the kidney at the hilum. Alternative methods when approach through

* *Traité d'Urologie*, 1935, ii, 1002
† *Acta Urol.*, 1947 1, 412.

the parenchyma is unavoidable are the high frequency knife or division of renal tissue with silver wire or stout silkworm gut introduced on a blunt needle. None of these methods is immune from secondary hæmorrhage

Results of operations performed for stone in the kidney—The operations available are pyelolithotomy nephrolithotomy and nephrectomy and in studying results attention is drawn first of all, to a comparison of their relative operative mortality Of subsequent complications we are concerned with after the first two operations recurrence of stone in the same or the opposite kidney fistula formation and after nephrectomy formation of stone in the remaining kidney

At the 2nd Congress of the International Society of Urology held in 1924 were published answers to these questions from sources so widely separated that the figures announced may be reasonably accepted especially in view of the vast numbers of cases from which they were derived

1 *Operative mortality*—Cifuentes of Madrid carried out a collective investigation upon the mortality rate of each operation (*a*) Pyelolithotomy from the results of 25 surgeons there were in aseptic cases 18 deaths in 975 operations a mortality of 1 88 per cent In 178 infected cases there were 11 deaths a mortality of 6 17 per cent (*b*) Nephrolithotomy from the reports of approximately the same number of surgeons there were in 915 uninfected cases 76 deaths a mortality of 8 8 per cent whilst in 647 infected cases 86 died a mortality of 10 8 per cent (*c*) Nephrectomy showed 102 deaths in 1 265 cases giving a mortality of 8 per cent It is probable that the number of aseptic cases is too large for at any rate under the heading of nephrolithotomy Braasch contributed 188 infected cases with a mortality of 1 06 per cent but no uninfected cases for he considered all cases requiring this operation were infected the infection differing only in degree Winsbury White* reports a series of 228 operations with a mortality rate of 4 08 per cent Ninety-six had nephrectomy performed with 4 deaths 64 pyelolithotomy with 2 deaths and 84 nephrolithotomy or combined pyelo- and nephrolithotomy with no deaths

2 Recurrence.—The report upon recurrence of stone was considered at the same Congress by Brongersma Amsterdam. He found that in aseptic or low grade infection the recurrence rate was practically the same (16 2 per cent) whether nephro- or pyelolithotomy were carried out. Where marked infection was present the recurrence rate for either operation rose to about 50 per cent In only one case after 60 nephrectomies for stone was there calculus formation in the opposite kidney

Braasch and Foulds† reported results of an investigation upon 1 041 patients who had been subjected to operation for stone in the

* *Med. Press*, 1940, ccxiii, No. 5761
† *Trans. Amer. Assoc. Gen.-Urin. Surgeons*, 1923, xvi, 155.

kidney through a period of 22 years to discover the incidence of recurrence. *In the 919 who were traced it was found that 871* pyelolithotomies gave a recurrence rate of 11 85 per cent 104 nephrolithotomies of 24 per cent. whilst 827 nephrectomies showed only 2 75 *per cent stone formation in the opposite* kidney The results only include those where operation had been carried out at least 2 years before the report It was believed that many of the so-called recurrences were *stones left over from the primary operation* and that the incidence would be much reduced by the wider use of radiography The comparative rarity of opposite side stone formation *suggests a predisposing anatomical factor* in the affected kidney

3. **Fistula.**—Fistula formation can be briefly dismissed for this formerly the bugbear of at any rate pyelolithotomy is practically never seen under modern urological conditions No case has occurred in our experience Braasch and Foulds do not even mention it as a post-operative complication

4. Stricture.—The risk of stricture at the uretero-pelvic junction has been raised as an objection to pyelolithotomy by some surgeons. It has not occurred in our experience. *If the precautions outlined above* are observed the risk should be negligible.

OPERATIONS FOR TEMPORARY DEVIATION OF THE URINE IN THE UPPER URINARY TRACT

Renal drainage may be required in the *following* circumstances —

(i) As a preliminary to nephrectomy in infected hydronephrosis or pyonephrosis in order (*a*) to combat the mass influence of sepsis and thereby to reduce toxæmia and (*b*) to *allow the kidney to shrink and* so render the subsequent nephrectomy less difficult and dangerous.

(ii) As a preliminary to a plastic operation for hydronephrosis when infection already exists

(iii) As a necessary part of the plastic operation and performed concurrently

(iv) As a preliminary to the operation *of uretero-colostomy* where the condition demanding that operation has already produced hydronephrosis and hydro-ureter with sepsis in the upper tract.

(v) *In certain cases of calculous* anuria where the constitutional state forbids lithotomy and catheterization of the ureter fails to drain the pelvis Occasionally the stone responsible may lie within easy *access and can be removed at the time* of the drainage without adding to the risk. Often a stone in the ureter will pass spontaneously after nephrostomy

(vi) In *some cases of* nephrolithotomy (*see* p 2350)

Methods of drainage.—Although the object is to drain the renal pelvis it is not advisable to do so by direct incision as the pelvis is less accessible and less manageable Further a tube *introduced*

directly into the pelvis cannot usually be replaced When the obstructive cause demanding the operation has been relieved the healing of a pelvis long drained may be delayed On the other hand the advantages of pyelostomy are (1) its ease of performance if the pelvis is greatly distended (2) absence of risk of hæmorrhage. The disadvantages however outweigh the advantages and therefore nephrostomy is generally accepted to be the better choice.

Nephrostomy

Where nephrostomy is performed as a preliminary stage of nephrectomy a small wound of approach is an advantage making the second operation easier An incision at right angles to the usual curved loin incision for nephrectomy will interfere less with the normal arrangement of the muscle strata and thus will preserve landmarks which are

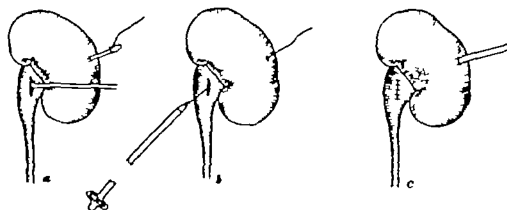


Fig. 969—Nephrostomy Cabot's Method. Suitable in the absence of marked hydronephrosis. (a) A malleable probe introduced through a pyelotomy incision is coaxed through a lower calyx and penetrates the parenchyma and capsule A strong thread is attached (b) By withdrawing the probe the thread is carried across the kidney and out of the pelvic opening The thread is stitched to the bevelled proximal end of a Malécot tube (c) The Malécot tube has been carried up into the kidney leaving its expanded extremity within the pelvis. The pyelotomy wound is sutured.

so valuable in the subsequent nephrectomy As drainage in these cases is somewhat crude and calls for little delicacy of technique the small incision is adequate The kidney is easily felt incised and the pus evacuated A finger is introduced and breaks down septa and a wide straight tube with lateral openings is placed in the deepest part of the kidney cavity

If kidney drainage is likely to be required for a considerable time or possibly permanently a more refined technique is called for with wider exposure of the kidney It may be necessary to dislocate the kidney from its bed and to perform the operation on the loin

(i) **Cabot's method.**—(Fig 969)—A bent uterine sound is introduced through a pelvic stab and traverses a lower calyx the kidney substance and capsule A stout silk thread is then tied to its distal end and carried through the pelvic opening by manipulation of the

sound. To the end of the silk which has been so conducted through the pelvic wound the bevelled proximal extremity of a No. 24 Ch. Malécot tube is attached and drawn through the pelvis and parenchyma, by traction on the silk, leaving the expanded end within the pelvis. After replacing the kidney and suturing the wound the tube is stitched to the skin. If there is a likelihood of nephrostomy being permanent, the tube should be stitched low down anteriorly so that the patient may have his wound under control for changing the tube.

(ii) **Trocar-cannula method.**—The trocar-cannula outfit used for water-tight bladder drainage by the method of Kidd suffices for the

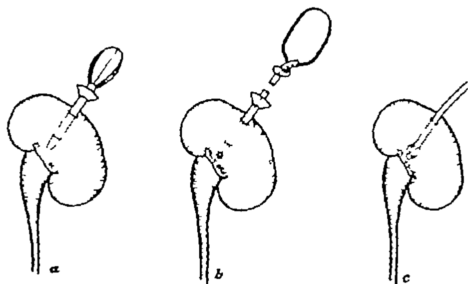


Fig. 970.—Nephrostomy by the trocar and cannula method.

The method suitable in the presence of marked hydronephrosis. (a) the trocar-cannula is plunged into the dilated pelvis. (b) the trocar is removed and a Malécot tube on an introducer is passed through the cannula. (c) the cannula is withdrawn over the tube leaving the tube *in situ*.

Note.—In practice nephrostomy should be established at a lower level than the figures indicate to avoid the 12th rib.

performance of this operation, but this is not suitable unless considerable dilatation exists (Fig. 970).

Marion uses a method similar to Cabot's, passing a curved clamp through a pyelotomy incision and so across the kidney through a calyx. The jaws are opened outside the capsule to receive a tube, which is thus drawn into the pelvis.

Mobilization of the kidney will probably be unnecessary in these operations.

A tube introduced by either method may be left undisturbed for three weeks or longer if draining properly before changing is necessary. It may then be replaced by a similar or a straight tube held in place by a rubber flange which is retained in contact with the skin by a suitable belt. Water-tight drainage into a bottle can usually be maintained and a patient may carry on tolerably comfortably in this way for months or even years if need be. Irrigation through the tube

should be established early after the operation 1 in 10 000 silver nitrate solution is generally used or dilute acetic acid where the urine tends to alkalinity

Post-operative treatment—Where as is commonly the case the necessity for nephrostomy arises from causes provoking renal failure measures must be adopted to stimulate restoration of function as well as to inhibit the effects of uræmia and toxæmia. Glucose by the mouth rectum and veins is valuable Bicarbonate of soda is used if the alkali reserve is deficient Diuresis is stimulated by forced fluid in take by mouth rectal and intravenous salines Additionally intra venous infusions of glucose sodium lactate and sodium sulphate (an isotonic solution) by the drip method are strongly advocated but a careful watch must be kept that the myocardium is equal to the strain of the volume of the extra load of fluid Œdema of the ankles and pulmonary bases the character of the pulse blood pressure and the nature of the respirations must be observed carefully

Urinary antiseptics by the mouth are better avoided during the critical stages Sulphonamides may be given where the septic element predominates but mandelic acid only with great caution for it damages renal epithelium and requires restriction of fluid intake which jeopardizes the vital function of the kidney In cases of severe infection streptomycin may be of great value if the organism present in the urine is susceptible to this antibiotic.

PLASTIC OPERATIONS ON THE UPPER END OF THE URETER AND RENAL PELVIS

These operations are required for obstruction at the upper end of the ureter and are most suitable when hydronephrosis is of the pelvic type It is important for the success of the operations that the kidney should be free from infection or if bacteria are present in the urine that the infection should be mild Modern urinary antiseptics may procure the necessary standard but if doubt remains preliminary nephrostomy should be considered

Before operating the surgeon must know the site of the obstruction if possible the nature of the obstruction the extent of dilatation of the kidney the existence of a second kidney and the functional capacity of each kidney The presence of an obstruction and its site are investigated by an opaque ureteric catheter pyelography and uretero-graphy the degree of its effects are more fully shown by excretion urography The best method for confirming the seat of obstruction is by retrograde pyelography (with sodium iodide solution 18 5 per cent) where full length passage of the opaque catheter is possible As the catheter is withdrawn down the ureter the opaque solution is slowly introduced by a syringe Immediate radiography is carried out and shows a too abrupt uretero-pelvic angle or too sudden a transition from the broad to the narrow zones of the

ureter Radio-transparent stones may occasionally be identified and localized in this way and will explain the cause of the hydronephrosis. The Trendelenburg posture may make pyelo-ureterography possible when passage of the ureteral catheter is checked. Stone is never the cause of hydronephrosis requiring a plastic operation The second kidney is investigated by all means that are employed when nephrectomy is contemplated (*see* p 2232)

In bilateral hydronephrosis the less affected side should be operated upon first There are four essential objects for the success of these operations (1) removal of the obstruction (2) reduction of the size of the renal pelvis (3) fixation of the kidney (4) relief of pain.

Removal of the obstruction.—Unless the shadow of a calculus or a definite kink has been demonstrated by pyelography the cause will be discovered only at operation so that the early steps are exploratory The kidney is exposed by a curved lumbar incision which is carried well forwards to give ample exposure. The fascia and fat are dissected forwards in a sheet and the lower part of the distended pelvis is demonstrated The ureter is now exposed below the kidney and followed upwards At this part it will usually be found normal in size and appearance.



Fig 971—Ureter obstructed by leash of aberrant vessels.

At the lower margin of the distended pelvis the ureter may apparently disappear, where it is overlapped by the sac. If the hydronephrosis is very large and tense it may be necessary to tap it to obtain space and to follow the ureter but this is seldom necessary At or near the uretero-pelvic junction one of several conditions may be present as the explanation of the obstruction The more common of these are (*a*) aberrant vessels (*b*) adhesions binding the ureter to the renal pelvis (*c*) narrowing of the upper end of the ureter (*d*) misplacement of the ureter with production of a valve-like opening It must be added however that in many cases no obstructive cause can be found Such cases have been described by Von Lichtenberg and others as functional or dynamic

(*a*) **Aberrant vessels.**—A vessel or leash of aberrant renal vessels may be hidden beneath the over lapping renal pelvis and is exposed on raising the lower border of the sac The ureter is angled as it

passes over and behind this When a vessel is the cause of the obstruction it crosses the ureter a short distance below the actual uretero-pelvic junction (Fig 971)

The vessels as a rule pass to the lower part of the hilum They are temporarily occluded (stretched on an untied catgut ligature) to allow the effect upon the renal vascularity to be noted The lower pole of the kidney or a more extensive area may gradually assume a deep plum colour or fail to bleed when incised from interference with the circulation The upper end of the ureter should meanwhile be examined to ascertain if a permanent narrowing is present either as a result of or independently of the pressure of the vessels When the surgeon has satisfied himself that temporary occlusion of the vessels has caused no vascular interference the vessels are divided and ligated

The distended pelvis is gently compressed by the hand and if it empties readily the outlet of the renal pelvis is regarded as freed Vessels responsible for pressure obstruction upon the pelvis uretero-pelvic junction or ureter are either the posterior branch of the renal artery or abnormal trunks from the aorta notably one rising one to three inches below the renal artery and passing upwards and outwards to the lower pole of the kidney The last vessel may be as large as a ureter and strongly resemble it in appearance and position when present it will anchor the kidney and render delivery difficult The extent of the distribution of any of these vessels may be so important that if division and ligature has obviously interfered with renal vascularity it may be wiser to resect the lower pole of the kidney or to carry out nephrectomy Alternatively it may be better to preserve the artery and to divide and implant the ureter by the Küster or V Lichtenberg (I or II) techniques (*see* p 2268)



Fig. 972 —Hydronephrosis section of aberrant vessels plastic operation on stenosed upper ureter

Veins accompanying or independent of arteries may also be obstructing factors Very frequently one of the other forms of obstruction is present in addition to the pressure of the aberrant vessels and must be dealt with (Fig 972)

Hamilton Stewart's operation.—Hamilton Stewart* has described

* Brit Journ Surg 1947 xxxv 51

an operation for obstruction due to aberrant vessels which does not involve division of the vessels or opening the urinary tract. All adhesions around the upper ureter and renal pelvis are divided and the leash of aberrant vessels is freed. This should release any tension in the renal pelvis The capsule is then reflected from the front of the upper and lower poles of the kidney and the latter is then moulded so as to bring the upper and lower poles together where the capsule has been stripped Plain catgut sutures retain the kidney in its new shape After this a long strip of ribbon catgut is threaded under the capsule along the new convex border of the kidney and the ends sutured. Lastly the renal pelvis is plicated with catgut The effect of the manœuvre is to slide the leash of vessels upwards Eighteen cases are reported with relief of pain in every case.

(*b*) **Adhesions** of the upper end will be found on following up the ureter its upper inch or so may be bound down to the face of the distended pelvis and the narrowing of the lumen is due to kinking from these bands The ureter should be freed from all adhesions until the point is reached where it leaves the surface of the distended pelvis. This may be at some distance above the lowest pole of the sac.

On reaching the exit of the ureter from the sac the ureter is sometimes found drawn up into the sac like a miniature intussusception and held in this position by a few strands of adhesions. The ureter can be drawn out of the invagination by pulling but on releasing it the intussusception reforms When all the adhesions are cleared the invagination may still recur and a plastic operation is then necessary for its correction

(*c*) **Narrowing**.—A small segment of the upper end of the ureter or the uretero-pelvic junction may be found to be attenuated evident both to the eye and to the touch. This condition may be present with or without a leash of aberrant vessels a plastic operation (pyelo-ureteroplasty) is then required (Figs. 972 and 973)



Fig. 973.—Pyelo-ureteroplasty (Fenger's operation) (*a*) The vertical incision (*b*) Transverse suturing

(*d*) **A valve** associated with a high placed uretero-pelvic junction.

When something more than division of aberrant vessels adhesions or a stricture is necessary the renal pelvis is opened by an incision in its longitudinal axis terminating about an inch above the uretero-pelvic junction The incision is usually made in the posterior wall of the pelvis but in some cases the lower part of the anterior wall is easier of access and the incision is made here The main renal vessels are on the anterior surface but take a very oblique course upwards and are well separated from a leash of aberrant vessels. After

removing the urine from the pelvis the lips of the wound ar
apart and the interior of the pelvis examined In the rare
where the obstruction is due to a papilloma of the renal pelvis
will have been suspected before opening the pelvis and will ap
at the wound when the pelvis is incised In such a case immed
nephrectomy or nephro-ureterectomy is performed

PLASTIC OPERATIONS ON THE URETERO-PELVIC JUNCTION

Where a narrowing is found at this part a grooved metal probe is passed into the pelvic outlet and down the ureter to define the length and calibre of the stricture

(i) **Incision from without (pyelo-ureteroplasty) Fenger's operation.**—(Fig 973) The strictured section is incised for about 1 inch upon a probe and the edges of the wound are sutured transversely with fine catgut following the principle of the operation of pyloroplasty This operation is also suitable for the functional or dynamic type of stricture a permanent hypertrophic contracture of the uretero-pelvic sphincter due to a neuro-muscular dysfunction The peculiarities of dynamic hydronephrosis have been brought to light by the more searching investigations of pyeloscopy combined with excretion urography for which Legueu and S H Harris are mainly responsible (*See* p 2271) An operation comparable to a Rammstedt incision for hypertrophic stenosis of the pylorus is occasionally performed in which the incision is deepened to but does not include the mucous membrane

(ii) **Incision from within the pelvis. Trendelenburg's operation.**—This may be used where the ureter is invaginated into the pelvis in the form of a valve Instead of the narrow segment being incised from without the lips of the incision in the pelvis are held widely apart the spur or nipple is picked up with forceps and cut with scissors one blade of which is in the pelvis the other in the ureter A valve opening is thus corrected Fibrotic thickening of the walls of the ureter and pelvis or adhesions outside may allow division in this way without penetration of the whole thickness but if a gap in the wall results a few suitably placed sutures drawing the incision together transverse to the axis of the

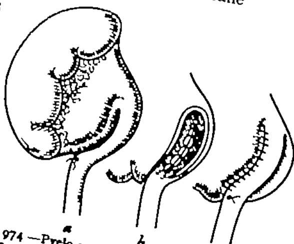


Fig 974 —Pyelo-ureterostomy (Von Lichtenberg's No. 1 operation) (*a*) The lumen of the pelvis and ureter are opened through the dotted line a fixation suture, below maintains contact. (*b*) Lateral sutur ing approximates the deep edges, thus bringing the lumens of each structure into a common cavity (*c*) completed when the superficial suturing is effected. This operation imitates the principles of gastro-duodenostomy

ureter will limit it and will at the same time give apposition of edges and prospect of primary union with a minimum of subsequent sclerosis This operation has been superseded by the more modern techniques one of us (J E) has found it however to have brought a lastingly good result in three cases

(iii) **New orifice.**—If a faulty position of the uretero-pelvic junction defies the possibility of dependent drainage a plastic operation limited to improving the existing orifice is likely to fail to overcome the obstruction and a new orifice must accordingly be made by some form of anastomosis at a lower level. An operation of this type may also be applicable where division of an abnormal obstructing artery of large size would possibly cause necrosis of a wide area of renal tissue the anastomosis may be so designed that the artery may be left undisturbed Strictures at the outlet may also be suitably treated by these operations

(*a*) **Von Lichtenberg s Method (Technique I)** —**Lateral pyelo-ureterostomy** (Fig 974) (comparable to Finney s gastro-duodenostomy) The free part of the ureter is drawn to the lowest part of the renal pelvis and the two are sutured side-to-side A horse-shoe incision is made into the lumens of the adjacent pelvis and ureter The inner edges are sutured with fine catgut and then the outer edges similarly

(*b*) **Kuster s operation.***—Pyelo-ureterostomy with transplantation. In this the ureter is severed from the pelvis and its open end is implanted into the lowest part of the pelvis either by end to-side anastomosis or laterally This is the prototype of V Lichtenberg s second operation (*see* p 2268) a method which has been well tested in recent years

(iv) **Reduction of the size of the renal pelvis.**—In spite of an operation successful in the immediate correction of obstruction at the pelvic outlet relapse is to be expected if a lax hydronephrotic sac co-exists. There is little tendency to spontaneous involution and it remains a large sac with a pool of retained urine which may reconstitute the obstruction by sagging over the upper ureter As a result the urine may eventually become infected or a stone may form. It is necessary therefore to perform some operation to reduce the size of the renal pelvis as a supplement to measures for the relief of the obstruction Three operations have been described and widely adopted a fourth (V Lichtenberg II) combines this principle with excision of a misplaced or obstructive uretero-pelvic junction —

(1) **Pyeloplication.**—Israel used this method which resembles an operation for dilated stomach. A row of catgut sutures is introduced in the wall of the pelvis so as to fold the wall inwards in a longitudinal line The sutures are of fine catgut and are placed by Lembert s method commencing just above the uretero-pelvic junction

* *Arch. f Klin. Chir* 1892, xliv 850

and in series upwards and outwards towards the kidney A wider hold is taken by each suture as the series goes upwards so as to fold in a greater area The sutures pass through the muscular wall but do not penetrate the mucous membrane It is recommended that the outer surface which will be brought into contact as two sides of the fold should be swabbed with a solution of silver nitrate or by 5 per cent carbolic acid to promote adhesion.

(2) **Resection of the renal pelvis** (Thomson Walker) *—A triangular portion of the wall of the pelvis with the apex an inch from the uretero-pelvic junction and the base near the lip of the hilum is removed (Fig 975) The posterior wall of the renal pelvis is usually resected but in some cases the anterior wall may be more readily accessible In the latter case the base of the triangle must be placed further from the margin of the hilum so as to avoid encroaching on the renal vessels In advanced cases an area of pelvic wall should be removed from both the anterior and the posterior surfaces The incision which has been used for emptying the renal pelvis is continued upwards and outwards towards the kidney and another carried upwards from its outer end parallel to the margin of the hilum and about ½ in from it This is continued to form a flap the extent of which will depend upon the size of the renal pelvis. The flap thus made is removed by a third incision from the apex to the base of the triangle The edges of the wound are united with a continuous suture of fine catgut which extends to about an inch from the uretero-pelvic junction. The poles of the flabby dilated kidney are carried forwards and inwards like horns as the suture closes the pelvic wound The wound is now covered with a flap of the fibrous capsule of the kidney which is turned down over it and kept in place by one or two stitches If a layer of peripelvic fat is available this will form a better covering for the posterior surface and should be used



Fig. 975.—Hydronephrosis Thomson Walker's operation for reduction of renal pelvis.

Before the pelvic wound is closed an incision should be made through the convex border of the kidney and a drainage-tube passed through

* Lancet, Aug. 11 1906, ii, 373.

this into the renal pelvis and in some cases where the plastic operation area appears to require support a ureteral catheter should be placed alongside the drainage-tube and passed through the pelvis and down the ureter The perirenal tissue is drained by a second tube Drainage of the renal pelvis is maintained for a week and the tube and catheter are then removed The renal pelvis after the operation has a conical

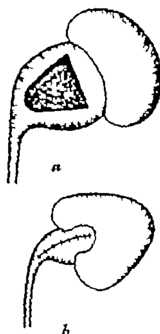


Fig. 976 —Thomson Walker s operation. (Pelvic Resection.) (a) Shows area of the pelvic wall excised (b) when the pelvis is reconstructed the kidney rendered lax by hydronephrosis, assumes a horseshoe shape.

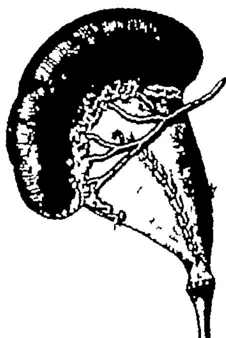


Fig 977 —Hydronephrosis : final stage of Thomson Walker's operation on ureter and renal pelvis, after section of aberrant vessels.

shape with the apex pointing towards the uretero-pelvic junction (Figs 976 and 977)

(8) **Reduction of the renal pelvis combined with removal of the uretero-pelvic junction (Von Lichtenberg s operation II) (Fig 978)** —The upper end of the ureter is divided transversely at the point where it springs from the pelvis or below a strictured length of ureter or valve. The pelvis is reduced by excising the anterior and posterior walls generously A thin rubber tube is passed down the ureter for two inches and fixed with a fine catgut suture at the upper end of the ureter Half an inch from the end of the ureter a catgut ligature is tied around the ureter which contains the tube. Holes are cut in the sides of the tube where it will be lying within the renal pelvis. Forceps are passed through the lowest calyx from outside the capsule and these grasp the end of the tube drawing it across the kidney substance eventually to lie outside the superficial wound where it will be

sutured to the skin in the final stages of the operation The edges of the pelvis are sutured in linear fashion the ureter with its contained tube taken through the inferior extremity of the line of apposition is included in the lowest stitches Reinforcing sutures are placed between the muscular coats of the ureter and the pelvis at the anastomosis Additional drainage of the pelvis is secured by placing a larger (nephrostomy) tube alongside the smaller one through the same calyx A third tube or rubber strip is employed for peri

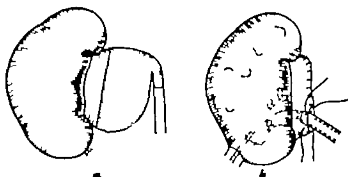


Fig 978 —Von Lichtenberg's operation for hydronephrosis by excision and implantation (No II operation.) (*a*) Condition before operation the stippled area will be excised (*b*) the pelvic stump is sutured leaving space in the lowest part to transmit the ureter supported on its tube and picked up by the lowest stitches at its entry The nephrostomy and ureter tubes are carried through the lowest calyx (after Victor Dix, Maingot's Postgraduate Surgery Vol. II By courtesy of Medical Publications, Ltd)

nephric drainage The ureter and nephrostomy tubes are removed in 10 to 14 days the perinephric drain on the fifth day

Von Lichtenberg* reports 80 operations for renal obstruction. In 41 per cent primary nephrectomy was required and in 59 per cent. a conservative operation could be employed In 27 per cent the obstruction was considered to be neurogenic

(4) **Anderson Hynes operation.**—Anderson and Hynes† devised their operation in 1947 They advise an anterior extraperitoneal approach through an incision from the tip of the tenth or eleventh rib to the umbilicus Having mobilized the kidney the redundant renal pelvis together with the uretero-pelvic junction is excised. The upper ureter is sectioned obliquely and an oblique anastomosis is made to a flap fashioned from the lower part of the renal pelvis (Fig 979) The upper half of the renal pelvis is closed by suturing Neither splinting of the anastomosis nor nephrostomy drainage is advised In performing this operation aberrant vessels to the lower pole can be preserved as the ureter is anastomosed to the pelvis after transposing the ureter to the other aspect of the vessels

* *Ann Surg* Nov 1935 cii, 849–862
† Anderson and Hynes (1949) *Brit J Urol* xxi, 209.

The originators report 48 operations with relief from pain in almost all. Only 8 kidneys had to be removed subsequently

One of us (H K V) has used this operation in several cases and regards it as particularly suitable in children.

Fixation of the kidney—Nephropexy is a necessary supplement to many operations designed to correct a mechanical defect Unless

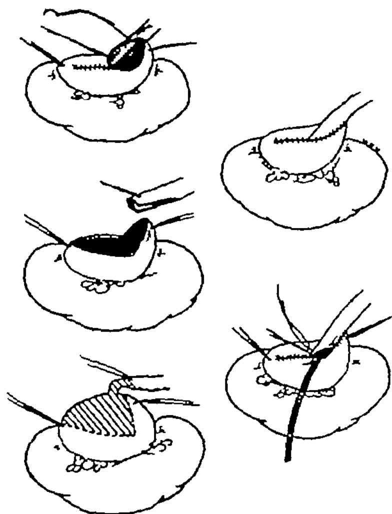


Fig 979—The stages in the Anderson-Hynes operation (see text.)
(*From Modern Trends in Urology Butterworth*)

the kidney and ureter are fixed in such a way as to assist drainage by preventing the drags or kinks of faulty alignment or undue mobility plastic operations cannot be permanently successful.

Relief of pain.—Fortunately this appears to be constant though not always lasting whichever operation is performed This has led to the belief that it is the outcome of sympathetic nerve division in freeing the kidney (*see* p 2271)

DANGERS AND SEQUELÆ OF OPERATIONS FOR HYDRONEPHROSIS

1 **Hæmorrhage.**—There is a danger of hæmorrhage into the hydronephrotic sac after the operation This may occur during the first two days or as late as a week after the operation No large vessels are cut in the wall of the hydronephrosis and a possible source of the hæmorrhage is necrosis of the kidney from vascular interference Late hæmorrhage may also be due to the pressure of one of the drainage tubes causing erosion of a vessel. Severe hæmorrhage should be met by opening up the wound in the kidney and either packing it or removing the kidney Blood transfusion is of great value as a hæmostatic agent as well as to replace blood lost

2. **Sepsis.**—To reduce post-operative infection a course of streptomycin for a few days is very valuable Occasionally sepsis may extend into the renal substance with formation of a cortical abscess Urine may extravasate through a path so established as well as through failure of primary union in the pelvic suture line Re-establishment of nephrostomy may be successful but nephrectomy is likely to be required later owing to persistence of the sepsis especially if aberrant vessels were divided at the primary operation

3 **Fistula.**—This may result from failure to re-establish the lumen of the pelvic outlet or it may be due to sepsis Whatever the cause an attempt should be made to pass a ureteric catheter and if successful to retain it *in situ* for a week If this fails another operative attempt may be made to establish the lumen but this should be deferred for some weeks if unsuccessful nephrectomy will be necessary

4 **Widespread necrosis of the kidney from vascular interference.**—In one of our cases (J E) a very stout female there was pyrexia about the 10th day and a deep-seated mass could be felt Pus pointed in three areas of the incision but the mass remained sinuses continued to discharge pus but no urine Intravenous pyelography showed no excretory function in the third week. Exploration then revealed a shrunken necrotic kidney riddled with abscesses in which no normal excreting substance remained Recovery after nephrectomy was uneventful In this case one of first degree hydronephrosis and duplication of the ureters compressed by an aberrant vessel a quite small vessel had been ligated. Hat it not been for the arrest of functional activity the chain of symptoms might have given reason to fear an indwelling swab! On the other hand we have occasionally divided quite large vessels and the lower pole of the kidney has darkened a little but no post-operative complications ensued

RENAL DENERVATION (SYMPATHECTOMY)

This operation originally introduced to procure relief from renal pain where no inflammatory or anatomical explanation was available has been widely adopted since S Harry Harris described the symptom complex which he named renal sympatheticotonus This an

obstructive nephropathy exhibiting the three stages of (i) irritability or systole (ii) exhaustion or diastole and (iii) paralysis or hydronephrosis he presumed to be due to over activity of the sympathetic nerve supply to the kidney Recurrence after temporary relief by injections of eserine (gr 1/60) and the absence of any demonstrable cause of organic obstruction are significant and with the rest of the clinical picture indicate the operation* Harris modified slightly the original technique of E Papin† in the method of denuding the renal vessels the kidney is exposed from the loin completely separated and delivered exposing the vascular pedicle the hilum and the upper end of the ureter Papin s method of gauze dissection of the vessels in a mesial direction hazards the tearing of veins a risk overcome in the Harris modification by elevating the pedicle on the index finger and carrying out instrumental dissection from within outwards commencing as far from the kidney as possible The vessels are denuded in turn and finally the renal pelvis the uretero-pelvic junction and the first inch of the ureter The application of 10 per cent carbolic acid to these structures may show up and destroy any overlooked fibrils Harris claimed good results of this operation with cautious case-selection and his claims have been substantiated by the subsequent experience of Wells Riches Oldham Underwood and others in this country their results having been proved by pyelographic reviews.

Recently it has been suggested that better denervation would be obtained by splanchnicectomy The same approach as in Smithwick s operation is used. We have had no personal experience of this operation but of late years many surgeons have been dissatisfied with the orthodox denervation

Results of Conservative Operations for Hydronephrosis

In an organ such as the kidney where the possibility of anatomical restoration is meagre the ideal of procuring a permanent state approaching the normal is seldom realized and the surgeon must content himself with relative rather than absolute perfection A far higher standard is aimed at to-day than hitherto when relief of pain sufficed as a measure of cure. E W Riches summarizing the criteria of success adds to the clinical or symptomatic result the need of study from the radiological, functional and bacteriological viewpoints. Without a universal acceptance of so high a standard analyses of reported results cannot render a statistical review convincing The following impressions however are gathered from a study of available records of the results of the four operative categories —

(i) *Division of vessels.*—Pain [illegible] ably relieved but dilatations sometimes remain and may re[illegible] ntary plastic surgery

* *Proc. Roy Soc. of Med* 1933, xxvii, 1497
† *Journ. U* [illegible] xi, 337

(ii) **Minor plastic procedures** of the pyelo-ureteroplasty (Fenger or Foley Y plasty) type appear to give good results in 75 per cent of cases

(iii) **Major plastic operations**—Where the pelvis is drastically resected with re-implantation of the ureter a wide divergence of results is apparent As in many cases such operation offers the only alternative to nephrectomy and if the radical removal of the obstructing cause is not practicable * a considerable proportion of failures is to be expected Thus Walters Cabot and Priestley† found benefit in under 50 per cent and secondary nephrectomy was necessary in 21 per cent of their cases In Von Lichtenberg s series of 47 cases nephrectomy was necessary in 7 per cent More recently E W Riches and Hamilton Bailey‡ reported two series of 81 and 26 cases respectively with good results in 61 and 54 per cent but others of the British school have been less fortunate

(iv) **Sympathectomy**—Reporting on a series of over 40 results where the operation was performed for the relief of renal pain J B Oldham§ observed that the relief of renal pain was practically universal At the same time pyelographic evidence proved anatomical and functional improvement E W Riches in a series of 18 cases was able to demonstrate the same benefits and in certain hitherto intractable cases of hydronephrosis with infection post-operative sterilization was achieved

THE OPERATIVE TREATMENT OF INJURIES OF THE KIDNEY

Before deciding to operate consideration must be given to the following questions —

(*a*) Is bleeding arrested or progressive to the extent of endangering life? Increasing pallor pulse rate restlessness and a suggestive blood picture should be noted

(*b*) Does the constitutional state demand or warrant immediate exploration or is it not wiser to give pre-operative intravenous infusions of saline or a blood transfusion? A blood transfusion is essential where hæmoglobin is under 60 per cent

(*c*) Are there associated abdominal or thoracic injuries requiring exploration?

(*d*) Is there a perinephric hæmatoma which is likely to suppurate or which already shows signs of suppuration?

(*e*) Is the damage to the kidney probably so severe (*a*) that it is unlikely to function efficiently as an excretory organ or (*b*) that by scar tissue formation the major conducting channels will be so distorted that a painful hydronephrosis is likely to follow? Intravenous pyelography will supply valuable information it will indicate the

* Von Lichtenberg, *Journ. Amer Med. Assoc.* 1929 xcii, 1706.
† *Journ. Urol.*, 1938, xxxviii, 668.
‡ *Proc Roy Soc. of Med.*, 1939 xxxii, 1457
§ *Ann. Roy Coll. Surg.*, 1950, vii, 222–45.

state of the opposite kidney and hence is useful in the early stages. Retrograde pyelography is only required to determine the existence of hydronephrosis as a later sequela its early use would add an unwarranted risk.

Such operations as are performed will follow the general principles of renal surgery The method of approach will depend upon whether the kidney alone is affected in which case the usual lumbar incision is made or whether associated grave injuries indicate laparotomy with if necessary transperitoneal or anterior extra-peritoneal nephrectomy or renal repair

Technique.—When exploring the kidney by the lumbar route extravasated blood and possibly urine will be encountered as the muscles are divided A large perinephric hæmatoma does not necessarily indicate a gross renal tear Blood clot and blood impregnated fat are removed and the kidney is freed delivering it upon or as near to the surface as possible Circumscribed splits or tears are sutured with mattress or figure-of-eight stitches but objection has been raised to the amount of renal destruction caused by such hæmostatic sutures. Albarran placed a network of catgut sutures around the kidney to hold the fragments together (cerclage du rein) In this method four stout catgut sutures two above and two below the pedicle embrace the kidney and are placed partly extra and partly sub-capsularly Lowsley has adopted a similar principle, using ribbon catgut When the capsule is intact contusion is at a minimum and there is little perinephric hæmatoma mattress sutures hold well and stop bleeding but under less favourable circumstances they cut into the kidney substance and are useless buffer pads of fat or muscle may then be placed under the loops of the stitches and provide a firmer hold or the same object may be achieved by placing catgut sutures parallel with the edges of the wound to be closed and embracing these in the loops of straight sutures (Fig 980) If a section of kidney for instance one or other pole is extensively damaged it should be removed and the adjacent surfaces sutured after the interposition of a pad of fat or muscle in the manner described under excision of a serous cyst (p 2289)

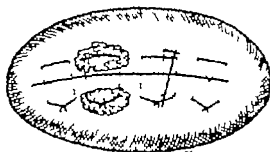


Fig 980.—Methods of suturing (numbered from left to right).

(i) A mattress-suture.
(ii) A mattress-suture tied over buffer pads of fat or muscle.
(iii) A plain suture tied over a mattress-suture which prevents the plain through-and-through stitch from cutting into the renal substance.
(iv) The figure-of-eight suture.

Comminution or pulping calls for nephrectomy if the general state warrants it otherwise tight gauze packing is used as a temporary step especially in stabs or gun-shot wounds. Established sepsis will

generally require nephrectomy Continuous intravenous saline and glucose drip infusion or blood transfusion may be life saving measures

In contrast with injuries to the bladder and urethra a policy of procrastination in deciding the time of operation may be adopted with advantage extravasation of urine is seldom to be feared for the pelvis and calyces are seldom grossly injured and moreover a kidney so severely damaged ceases to excrete long enough for the appearance of other physical signs which would give definite indications for or against operation

Hæmaturia from a ruptured kidney may be severe enough to give clot retention in the bladder in about 8 per cent of cases Bigelow s evacuator and the intied catheter will overcome this difficulty

Certain late results of renal injuries may require operation Amongst these are stone formation chronic sepsis and hydronephrosis Hydronephrosis is usually of the renal type and is caused by distortion of the calyces from fibrous tissue formation Attention is drawn to the condition by intractable pain and nephrectomy will then be required

Causes predisposing to rupture.—Developmental defects and disease render the kidney susceptible to rupture even as the result of a mild trauma Of the diseases hydro- and pyonephrosis tuberculosis lithiasis and polycystic disease are recognized The horseshoe kidney furnishes the best example of a developmental cause its exposed position fixation and fragile parenchyma stretched over dilated calyces accounts for this tendency Three cases encountered by one of us (J E) were mild and the tears were easily repaired by mattress suturing More severe injuries may require heminephrectomy

OPERATIONS ON ANOMALOUS KIDNEYS

The cystoscopic demonstration of ureteric orifices of normal appearance situation and excreting power does not necessarily indicate normal kidneys malformation may exist such as solitary horseshoe or a unilateral fused kidney Pyelography provides the proof More attention is now directed to these abnormalities than formerly on account of the ever increasing clinical recognition of upper tract pathology by excretion urography and its wider admission to the scope of surgery Eccentricities of the ureteric orifices such as multiplicity and abnormality of situation are recognized cystoscopically urethroscopically and on vaginal examination.

(*a*) **Horseshoe kidney**—Operation may be required for (1) *pain* due to tension within the isthmus or to pressure of it upon adjacent nerves (2) *hydronephrosis* from obstruction of the ureter by the isthmus heminephrectomy is required if hydronephrosis of one kidney is too advanced for conservation (3) *calculi* in the pelvis or calyces Pyelolithotomy unless the patient is unduly stout generally presents no difficulty for the anteriorly placed pelvis is usually

establishing drainage at the completion of this operation it is essential to avoid placing a rigid tube in contact with the iliac vessels whose course it would cross as it passes to the ureter Hæmorrhage has arisen from erosion of the vessel walls by pressure of an unyielding tube corrugated rubber tissue being resilient is free from this danger

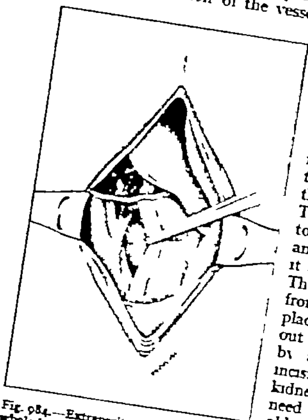


Fig. 984.—Extraperitoneal exposure of the whole length of the pelvic ureter through the median sub-umbilical incision.

Note the dilated ureter crossed by the vas the superior vesical artery has been divided to allow forward and lateral dislocation of the posterior surface of the bladder

The rectus incision.—This is an alternative to the iliac. A vertical incision is made ¾ in. mesial to the linea semilunaris as long as is necessary The anterior layer of the rectus sheath is divided and the muscle is split or retracted The transversalis fascia is incised to the full length of the wound and the plane of cleavage between it and the peritoneum opened up The peritoneum is fully separated from the abdominal wall and displaced upwards and mesially without being opened The ureter may by adjusting the length of the incision be explored from the kidney to as low in the pelvis as need be. The operation is suitable in thin patients but it does not give such good exposure to the abdominal course of the ureter as do the other methods. It may leave a weak abdominal wall.

3 Median sub-umbilical incision.—This made from the pubic symphysis to the umbilicus in the midline gives the most direct exposure of the pelvic ureter* (Fig 954)

Technique.—The linea alba and transversalis fascia are incised and the extraperitoneal fat exposed. The patient is placed in the Trendelenburg position and the peritoneum is fully stripped from the iliac fossa and the lateral pelvic wall on the side of the ureteric lesion. This stripping should be commenced over the bladder and is then carried on across the external wall of the pelvis. The external iliac vessels are exposed and the peritoneum stripped inwards from the iliac fossa laying bare the common iliac vessels and the lower part of the muscles of the posterior abdominal wall Alternatively the displacement of the peritoneum may be begun in the iliac fossa the common iliac vessels exposed and the stripping continued into the pelvis following the line of the ureter downwards. Self retaining

* J Swift Joly *Lancet*, 1913 i 1602

abdominal retractors and good illumination are essential for this part of the operation By this route the lower part of both ureters can be readily exposed simultaneously

Difficulties and dangers—Certain difficulties may be encountered during this part of the operation Injury to the peritoneum may be

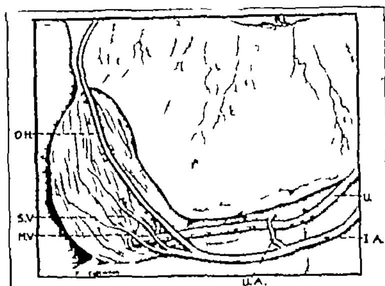


Fig 985—Relations of the lower end of the left ureter in the female.
The lateral aspect of the pelvic peritoneal sac is seen. *Drawn from Specimen 296, Room 2, Hunterian Collection, by permission of the Royal College of Surgeons.*
U ureter. IA, internal iliac artery UA, uterine artery OH, obliterated hypogastric artery SV and MV superior and middle vesical arteries. RL, round ligament.

produced in incautious stripping or by the sharp edge of a retractor The rent should be closed by a continuous catgut suture. In the female subject the broad and round ligaments prevent the free stripping of the peritoneum from below upwards It is better therefore in women to strip the peritoneum from the iliac fossa first and to follow the ureter downwards tracking it carefully beneath the base of the broad ligament and taking pains to avoid the numerous vessels (Fig 985) In the male the displacement may begin at the bladder or at the brim of the pelvis. In either case the vas deferens with its accompanying vessels stretching across from the wall of the pelvis to the bladder limits the exposure of the pelvic floor The vas is isolated and the ureter may be exposed above or below it (Fig 986)

If a hernia is present the peritoneum is adherent round the internal abdominal ring and this interferes with the full exposure of the lower segment of the ureter but the sac can usually be easily separated and drawn into the abdomen thus freeing the peritoneum Previous appendicitis operations on the female pelvic viscera pelvic cellulitis the massive scar tissue round a ureteral fistula all interfere with the stripping of the peritoneum and may necessitate opening the peritoneum and performing the operation partly as an extra and partly as an intraperitoneal procedure

Hæmorrhage may cause difficulty In a straightforward case it is due to want of care in preparing the ureter and avoiding the internal iliac vein and its tributaries With a deep wound in a stout subject especially a multipara venous hæmorrhage may cause a good deal of

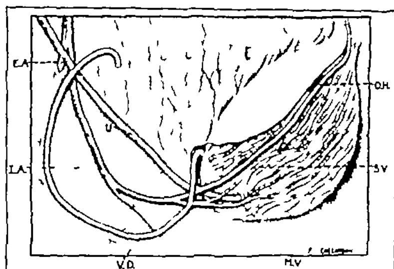


Fig 986—Relations of the lower end of the right ureter in the male.
Drawn from Specimen 291 Room 2, Hunterian Collection, by permission of the Royal College of Surgeons.
U ureter EA and IA, external and internal iliac arteries. VD, vas deferens (divided). SV and MV superior and middle vesical arteries. OH, obliterated hypogastric artery
(Figs. 984–6 are reproduced from the Proceedings of the Royal Society of Medicine, xxiv 184, Sect. Urol. I by permission of the Honorary Editors).

trouble. Free exposure and a good light are essential for controlling the bleeding

Difficulty in finding the ureter may cause delay in the operation. The ureter when supple and neither thickened by inflammation nor dilated adheres to the peritoneum in the pelvis and may be displaced with it and overlooked When the ureteral wall is thick there is no difficulty in finding it From its unexpected size (megalo-ureter) it may not at first be recognized as a dilated ureter If any difficulty is encountered search should be made at the bifurcation of the common iliac vessels over which the ureter passes into the pelvis and to which the wall is sometimes firmly adherent. In the deeper part of the pelvis some doubt may be felt in deciding at what depth the ureter lies Here the spine of the ischium should form the guide the ureter crossing the tip of this and lying directly upon it or the vas may be traced downwards and will lead the surgeon to it The passage of a catheter or a bougie up the ureter by cystoscope before commencing the operation is often of service

A drainage tube or rubber tissue is placed near an incision in the ureter or if the ureter has been removed down to the pelvic floor The abdominal wound is closed in layers The drain should be retained for five days

Alternative methods of approaching the pelvic ureter are given on p 2290

Transperitoneal exposure of the ureter—This approach offers no advantages for exposure of the abdominal ureter its use is limited to a few operations upon the pelvic section The abdomen is opened by a median or para median incision from the pubic symphysis to the umbilicus The full Trendelenburg position is adopted and the intestines are packed aside The ureter is seen at the brim of the pelvis where it crosses the bifurcation of the iliac artery and is followed up or down from this point To expose it the peritoneum over it is incised when it can be stripped from its bed

The advantages of the transperitoneal approach are the rapidity and ease with which the ureter is exposed The disadvantages are the liability to peritoneal infection in septic cases and the difficulty of draining the peri ureteral space The disadvantages greatly outweigh the advantages and the transperitoneal method is used in only a few cases for instance occasionally for ureterolithotomy in the female it is a necessary part of the operation of transplantation of the ureters into the bowel It is also necessary after certain surgical traumata and valuable when fistula of the ureter has followed extensive gynæcological operations such as panhysterectomy for in such cases the lower segment of the ureter is embedded in a mass of fibrous scar tissue and the peritoneum of the pelvis is adherent Extraperitoneal exposure is then often difficult and may be impossible.

Complete nephro-ureterectomy has been carried out through a transperitoneal approach then using a para rectal or rectus splitting incision but would never be deliberately chosen

URETEROLITHOTOMY

About 75 per cent of calculi migrating from the kidney and temporarily impacted in the ureter are passed without external operation The stones may be passed naturally or the process may be assisted by the pressure of artificial diuresis aided by belladonna or its derivatives or as a result of endoscopic measures (p 2295) In the remaining cases open operation is necessary because of the size and shape of the calculus hydro-ureter and hydronephrosis pain infection or calculous anuria

Where a stone is lodged in the ureter simultaneously with a stone in the kidney of the same side it is the rule to remove the ureter stone first unless the other kidney is non functioning or in the presence of calculous anuria when a primary kidney operation serves the dual purpose of stone removal and nephrostomy thereby safeguarding against failure of renal function If the kidney is operated upon first the ureter stone will be removed endoscopically or surgically on the return to satisfactory health and recovery of renal function.

The common sites of impaction are at the upper end of the ureter at the brim of the pelvis or just outside the bladder in the prevesical spindle The exposure of the ureter at these levels has been described

In the lumbar segment the ureter is easily drawn to the wound If the stone cannot be manipulated into the renal pelvis and removed

by pyelolithotomy the ureter is necessarily incised In the pelvic ureter when the stone has been impacted for some time there may be *much matting of the peritoneal tissues and the ureter* must be mobilized with great care to avoid damage to vessels and bowel A sling of gauze or a retractor introduced beneath it supports and stabilizes the ureter while it is incised and the stone is removed *The stone is carefully* loosened and removed avoiding fragmentation. A ureteric catheter or bougie is passed down into the bladder to prove patency of the duct unless endoscopic catheterization has previously been done One or



Fig 987 —Thomson-Walker s ureter stone-scoop.

more stitches of fine catgut are generally used to approximate the outer coats of the ureter Too many or too closely placed sutures strangulate the edges and are responsible for delayed healing Sutures which enter the mucosa if not absorbed may encourage further stone formation

The region of the ureteric incision requires prolonged drainage to prevent accumulation of extravasated urine which would unless given easy escape promote abscess formation with delayed healing and the possibility *of a persistent fistula or stricture formation.*

If a stone lies low in the ureter and cannot be felt in a stout patient or in the female the lower ureter being difficult to reach the tube may be opened at a convenient spot near the brim of the pelvis and Thomson Walker s flexible ureteral scoop (Fig 987) introduced This may be coaxed round and will often deliver the stone. If the scoop fails to disimpact the stone a second incision is made over it and the calculus prised out

It is important to bear in mind that ureteric stones may readily escape *up* the ureter in the course of an operation a dilated ureter *the Trendelenburg position and a spinal anæsthetic* all aiding their migration For these reasons it is often wiser in the search for low ureteric stones to expose the ureter at the pelvic brim and to support it by a gauze sling before actually attacking the supposed position of the stone. One of us (J E) once failed to find a stone at the lower end of the ureter which X rays had proved to have lain there for a year A subsequent X-ray showed the stone to be in the kidney it was passed naturally a month after the operation.

During manipulation of the vesical extremity a stone can escape into the bladder In such a case an incision may be made into the *posterior wall of the bladder and the stone* removed the incision is closed by catgut sutures. No harm will arise if suitable retro-vesical drainage is established and a urethral catheter is tied in for 3 or 4 days.

Removal of the stone from the bladder is however preferably carried out with the aid of a Bigelow s evacuator

Vaginal ureterolithotomy —This is an approach which is occasionally useful when a stone is impacted very low in the ureter and is palpable on vaginal examination By a small incision in the lateral fornix we have twice been able to remove such a stone The ureter need not be sutured. There is no shock associated with this operation and in neither case did a fistula result

Finally it cannot be emphasized too strongly that no operation for the removal of a ureteric stone should be undertaken without taking an X ray photograph immediately before the operation

Operations in Calculous Anuria

The importance of operation in this condition was proved long ago by the figures given by Morris * for in cases not operated upon there were only 20 8 per cent recoveries whereas 51 per cent recovered after operation. The main difficulty lies in the determination of the side for operation in bilateral lithiasis X rays and ureteral catheterization help the surgeon to arrive at a decision The side selected for operation should be that which is from a study of the history and clinical data the most recently and consequently the less destructively affected The nature of the operation depends upon the discovery of a tangible cause a stone lodged in the renal pelvis or ureter should be operated on Radiology will generally indicate that a stone in the ureter often the ureter of the sole functioning kidney is responsible at any rate in those cases where operative interference offers a fair chance of relief Where both kidneys are choked with stones there is little to expect from surgery Where a stone is present in the ureter of the kidney which has given evidence of recent activity by pain an attempt should be made to remove it if such removal can be carried out by an operation which the patient can stand A minor operation the liberating of a stone impacted at the ureteric meatus or a vaginal ureterolithotomy will produce little constitutional disturbance and may be performed even in the presence of pronounced uræmia. Stones higher in the ureter may be so loosely held by the muscle coats of the duct that they will allow the passage past them of a ureteric catheter introduced cystoscopically This is the process to adopt in impaction in any part except the extreme ends and if so coaxed beyond the stone, the catheter should be left *in situ* to drain the kidney for a week or longer On its removal urine may escape naturally and the stone not uncommonly passes spontaneously after a short interval, or it may then be removed surgically if the patient sufficiently recovers from the uræmia. Failure to establish catheter drainage in this way will call for immediate nephrostomy If the stone is impacted in the upper end or in the renal pelvis the usual renal exposure is employed and the stone removed in the ways described on p 2252 Temporary

* *Surg of the Kidney and Ureter* Vol. II.

nephrostomy occasionally pyelostomy even after successful lithotomy will aid recovery of renal function The added operative danger of renal drainage when the kidney has already been exposed is minimal The after-care and especial means for hastening the return of renal function have already been detailed

Ureterectomy

Ureterectomy is performed either as a separate operation following nephrectomy after an interval of time or in combination with it and simultaneously (nephro-ureterectomy) The first to remove the whole length of the ureter were Reynier in 1892 and Poncet in 1893 each being driven to undertake the operation from persistence of sinuses after nephrectomy performed in the one case for pyonephrosis and in the other for tuberculosis Howard A Kelly* was the first deliberately to attempt primary one-stage nephro-ureterectomy and he reported three cases in 1896 tuberculosis being the indication in each. Primary removal of the whole length of the ureter supplemental to nephrectomy being an operation of considerable magnitude has naturally been accepted with reluctance and further in the majority of examples of ureteritis secondary to renal infection whether tuberculous or pyogenic resolution is satisfactory after nephrectomy with partial ureterectomy *Of late years there has been a swing back in many genito-urinary clinics to primary nephro-ureterectomy in tuberculous cases The lumbo-ilio-inguinal incision originally* adopted by Morris, Kelly Albarran and Israel for the radical operation jeopardized the muscles and nerves of the abdominal wall and no doubt brought the operation into further disfavour In 1911 Lilienthal† called attention to the complications of the tuberculous ureter stump and described a two-way approach by which the abdominal muscles were preserved the ureter being exposed through a separate iliac muscle-splitting incision. This principle for performing nephro-ureterectomy has become universally adopted. Amongst those who are responsible for its establishment are Kidd, Swift Joly Judd and more recently E Papin.

Surgeons still differ in their choice of approach to the pelvic ureter Some prefer the oblique route the muscles being split or divided whilst others adopt a vertical incision placed mesially from the umbilicus to the symphysis pubis or more laterally through any part of the rectus sheath the rectus muscle then being split or displaced. Vertical incisions seem to offer a better approach to the juxtavesical and intra mural ureter allow more complete mobilization of the bladder are drained with greater safety since tubes or other devices do not lie in contact with the iliac vessels. All the operations are performed extraperitoneally the transperitoneal route having been abandoned many years ago as an operation of choice.

Interval ureterectomy is required where the ureteric stump fails

* *Johns Hopkins' Hosp. Bull.*, March 31 1896, vii, 31.
† *Ann Surg.*, 1911, liii, 821

to atrophy to a fibrotic cord and remains evidently the seat of a pathological process. The indications for its removal are (1) papillomatosis, (2) tuberculosis, (3) hydro- or pyo-ureter, where the lower end is (*a*) obstructed by a stricture or a stone, or (*b*) unduly patent when the stump is in fact a bladder diverticulum, probably infected.

(1) **Papillomatosis.**—Cystoscopic recognition of the escape of blood from the orifice of the stump indicates the presence of transplant growths in any part of the length, including the intra mural section.

(2) **Tuberculosis.**—Thomson Walker* found that 8 per cent. of his cases required a late ureterectomy. He, like the majority of surgeons, preferred nephrectomy and partial ureterectomy as a primary step, deferring a review of the ureter for six months. Persistence of T. bacilluria and cystitis in the presence of a healthy opposite kidney indicated removal of the ureter to the bladder.

(3) **Hydro- or pyo-ureter.**—In this group colicky pain and persistence of pyuria provide evidence of trouble arising from the stump. Radiography may aid the diagnosis by revealing a calculus shadow. If an opaque catheter can be introduced, its position will indicate the size and shape of the cul-de-sac, and this will be more precisely defined if an opaque medium is injected through the catheter.

If dilatation of the orifice or meatotomy followed by a course of lavage fail to relieve symptoms, excision of the stump is required. Unfortunately in these cases the operation may be an exceedingly difficult one, owing to peri ureteritis with dense adhesions.

Technique of ureterectomy.—Where a short stump is presumed the ureter is exposed through a median sub-umbilical incision. If a length of the abdominal ureter probably also remains it is better to incise an inch from the mid line, so that the rectus muscle may be split up for whatever length is found to be necessary. The ureter is exposed (*see* p. 2252) at the pelvic brim and traced up to its highest point. Separation here may be difficult from adhesions and the high Trendelenburg position with wide retraction is necessary. At the brim the ureter is separated with great care from the iliac vessels, a gauze sling is placed beneath it and held in forceps. The course in the male to the point of crossing by the vas, and in the female to the base of the broad ligament (that is to where it passes beneath the uterine artery), is usually exposed without great difficulty. Juxta vesical removal requires the exposure of a further 1½ to 2 in. of the tube and, to render this less difficult and dangerous, methods have been devised to mobilize the bladder by which the intra mural region is elevated. Since this viscus is anchored largely by the strong attachment of peritoneum for an area of 5 to 6 cm. in diameter surrounding the urachus, either this area may be detached by patient dissection or E. Papin's method of "extraperitonization" of the bladder may be adopted.† In this the bladder is cleared by blunt dissection laterally and from above downwards as far as possible until

* *Brit. Med. Journ.*, 1927, ii, 685.
† *Arch. des Mal. de Reins etc.*, 1926, i, 1.

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(3) **Hydro- or pyo-ureter**—In this group colicky pain and persistence of pyuria provide evidence of trouble arising from the stump Radiography may aid the diagnosis by revealing a calculus shadow If an opaque catheter can be introduced its position will indicate the size and shape of the cul-de-sac and this will be more precisely defined if an opaque medium is injected through the catheter

If dilatation of the orifice or meatotomy followed by a course of lavage fail to relieve symptoms excision of the stump is required Unfortunately in these cases the operation may be an exceedingly difficult one owing to peri-ureteritis with dense adhesions

Technique of ureterectomy—Where a short stump is presumed the ureter is exposed through a median sub-umbilical incision. If a length of the abdominal ureter probably also remains it is better to incise an inch from the mid line so that the rectus muscle may be split up for whatever length is found to be necessary The ureter is exposed (*see* p 2282) at the pelvic brim and traced up to its highest point Separation here may be difficult from adhesions and the high Trendelenburg position with wide retraction is necessary At the brim the ureter is separated with great care from the iliac vessels a gauze sling is placed beneath it and held in forceps The course in the male to the point of crossing by the vas and in the female to the base of the broad ligament (that is to where it passes beneath the uterine artery) is usually exposed without great difficulty Juxta vesical removal requires the exposure of a further 1½ to 2 in of the tube and, to render this less difficult and dangerous methods have been devised to mobilize the bladder by which the intra mural region is elevated Since this viscus is anchored largely by the strong attachment of peritoneum for an area of 5 to 6 cm in diameter surrounding the urachus either this area may be detached by patient dissection or E Papin's method of extraperitonization of the bladder may be adopted † In this the bladder is cleared by blunt dissection laterally and from above downwards as far as possible until

* Brit. Med. Journ., 1927 ii, 685.
† Arch. des Mal. des Reins etc 1926 x, 1

this becomes difficult from peritoneal attachment The peritoneum is then deliberately incised and this incision is continued laterally while drawing the bladder upwards and forwards The disc of peritoneum excluded from the rest of the sac remains adherent to the bladder and the gap is sutured As the result of this step the bladder held up by forceps or a stitch can be raised retracted or rotated and the structures crossing the termination of the ureter may be seen and handled with relative ease (Fig 988) The vas is easily seen and held aside. The uterine superior and middle vesical arteries appear as tense strands in the fibro-fatty tissue All such strands must therefore be double-clamped before division and carefully ligatured Greater difficulty in providing hæmostasis may be presented by the venous plexus which surrounds the ureter especially developed in multiparæ In some cases we have had to resort to packing as the only means of checking bleeding from these veins When the larger arteries have been divided and the bladder is satisfactorily elevated the ureter comes more and more into view and soon traction upon it is seen to draw up a knuckle of bladder wall. If the case is one of tuberculosis the ureter is grasped in a clamp placed flush with the bladder wall and a second clamp is placed a quarter of an inch higher The ureter is divided between these with a cautery or carbolized knife and both ends are ligated with 2/0 cat gut Cauterization of the lumen or excision of the intra mural ureter introduces the risk of wound infection from the bladder and is therefore better avoided

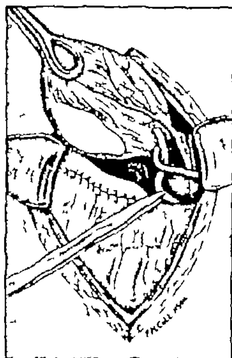


Fig 988 —Exposure of lower end of right ureter

Papin method of bladder extraperitonization has been employed. The relation of the vas and vesical vessels to the ureter is seen.

In the remainder of the cases with the exception of papillomatosis a similar procedure is adopted In papillomatosis especial attention must be given to the intra mural ureter either the whole of its extent is surrounded by a diathermy knife incision so that a disc of bladder wall is taken with the ureter or a wider area of bladder is included in the presence of a local vesical transplant of papilloma. In this case it will be necessary to open the bladder anteriorly in order to excise the growth from within The gap in the bladder is finally sutured and retrovesical drainage established. Where papillomatosis is suspected, or purely as a prophylactic measure the intra mural channel may be fulgurated before the lower ligature is applied, as

J C Colston has advised * Macalpine † however considers that in papillomatosis even this procedure let alone excision of a disc of bladder carries the risk of contaminating the wound with papilloma cells He recommends clamping and dividing the ureter with diathermy flush with the bladder and dealing with the intra mural portion by cystoscopic fulguration

Nephro-ureterectomy—This may be performed as a one-stage operation if that is within the capacity of the patient s endurance otherwise it is customary to defer the ureter removal for two to three weeks when the technique will not differ from that already described If performed in one stage it is preferable to free the kidney before the ureter for these reasons (i) Since nephrectomy *may* only be necessary it would be unreasonable to excise the ureter as a primary step (ii) If the patient is suffering from operative distress discontinuance is easier In uretero-nephrectomy skin implantation would be necessary until recovery was sufficiently advanced to warrant nephrectomy (iii) It is easier to turn the patient on the table from the lateral to the Trendelenburg posture

The kidney is freed by the usual lumbar method and the vascular pedicle is ligated and divided The ureter is separated down as far as the lumbar incision permits that is to the pelvic brim The kidney suspended on the ureter is left outside the lower end of the wound which is sutured beneath it in layers. The patient is then placed in the Trendelenburg position and a median sub-umbilical incision is made. The ureter is exposed in the pelvis in the manner already described its position is rendered more obvious by traction on the kidney which puts it on the stretch (Fig 989) The remainder of the technique for the ureter is the same as described on p 2289 By traction on the kidney it with the whole length of the ureter will come away in continuity The hypogastric wound is sutured except where traversed by a tube which drains the pelvic cellular tissue The loin need not be drained. Some surgeons after freeing the kidney prefer to push it down as far as possible into the

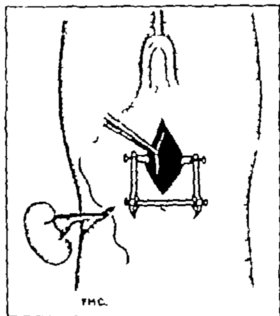


Fig 989 —Left nephro-ureterectomy The lowest superficial and deep stitches are placed but not tied until the kidney and ureter are removed, in case adhesions remain at the pelvic brim more easily freed from above.

* *Journ. Urol.*, 1933, xx, 110.
† *Brit. Journ Surg* 1947 xxxv 113.

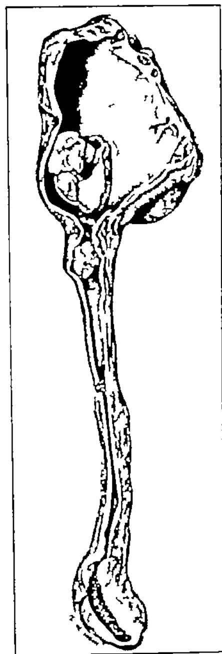


Fig 990.—Diffuse lithiasis of the kidney and whole length of the ureter

(Woman aged 42.) Juxta-vesical nephro-ureterectomy

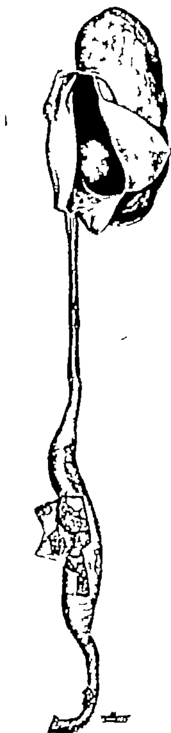


Fig. 991.—Primary papillomatosis of the ureter with transplants at the vesical end.

The kidney is hydronephrotic but the upper ureter is not dilated Removed by juxta-vesical nephro-ureterectomy from woman aged 62.

pelvis After making the midline incision and reflecting the peritoneum the kidney is sought and delivered downwards through the abdominal incision and the ureterectomy completed.

If the ureter is freed as a *primary step* (*ureteronephrectomy*) the Trendelenburg position is first adopted and the pelvic ureter is divided at the bladder end and freed as high as possible The wound is sutured except where a drainage tube traverses the abdominal wall to the pelvic floor The patient is then placed in the lateral position and the kidney exposed *Separation of an enlarged* adherent kidney is aided by an immediate finding and tracing up of the freed ureter to the renal pelvis (Gutierrez) Lumbar drainage is unnecessary

The indications for nephro-ureterectomy are the same as for ureterectomy (p 2289) In papilloma of the renal pelvis J Swift Joly * proved the *necessity for the primary* radical operation Opinion remains divided on the advisability of primary nephro ureterectomy in renal tuberculosis Lett† reviewed the complications arising from the tuberculous stump and urged wider adoption of primary ureterectomy to avoid them Many surgeons are guided by the characters of the ureter when seen and handled in the loin at nephrectomy



Fig 992 —Ulcero-cavernous renal tuberculosis with ureteritis and a breaking-down caseous focus at the vesical extremity

(Male aged 17.) Juxta vesical nephro-ureterectomy performed by one of us (J. E.).

(Figs. [illegible]–92 are reproduced from Proc. Roy Soc. Med. by permission of the Honorary Editors)

* *Fifth Congress Internat Soc of Urol*, 1933, p. 211 † *Lancet*, 1936, ii, 1312.

the outer coats of the ureter and the bladder muscle (Fig 995) A narrow drainage tube is inserted between the implanted ureter and the edges of the new opening to which it is held by one catgut suture. Its distal end will be carried through the anterior cystotomy incision and stitched to skin alongside the main bladder drainage tube. The tube as well as serving for drainage provides extra space for subsequent cicatricial contraction

Millin* has pointed out that freeing the ureter from the presacral curve renders its apposition to the bladder easier He was using a method of implantation described by Dodson† where the ureter is buried by a short Witzel type of suture After this a Cumming s nephrostomy tube is used as a ureteric splint. The end of this tube lies in the ureter and the tube passes out through the urethra, the

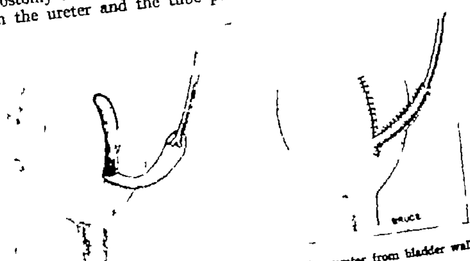


Fig 996 —Diagram to illustrate method of making ureter from bladder wall (Ockerblad and Boari)

distended bulb preventing it from slipping out of the bladder An attempt to preserve the valve-like lower end of the ureter is recommended by Patton ‡ He passes the ureter through the original ureteric meatus in the bladder (Transmeatal neo-cystostomy) In cases where a length of ureter has sloughed the defect can be overcome by fashioning a flap of bladder wall into a tube and anastomosing this by a few sutures to the distal end of the ureter as originally used by Boari in 1894 in dogs. Millin and others including Ockerblad § have used this method with conspicuous success. (Fig 996)

(ii) *When performed after partial cystectomy for tumour or diverticulectomy* —The procedure varies but little from (i) Cystotomy and partial cystectomy are the primary steps After removal of tissue invaded by growth in which the ureter is involved by the transvesical route the bladder is turned aside to give approach to the ureter as it traverses the pelvis The ureter-end after division is fashioned and

* Proc. Roy Soc. of Med 1949, xlii, No. 1 37
† Journ. Urol., 1946, lv 225
‡ Ibid 1938, xl, 1031
§ Ibid., 1947 lvii, 845.

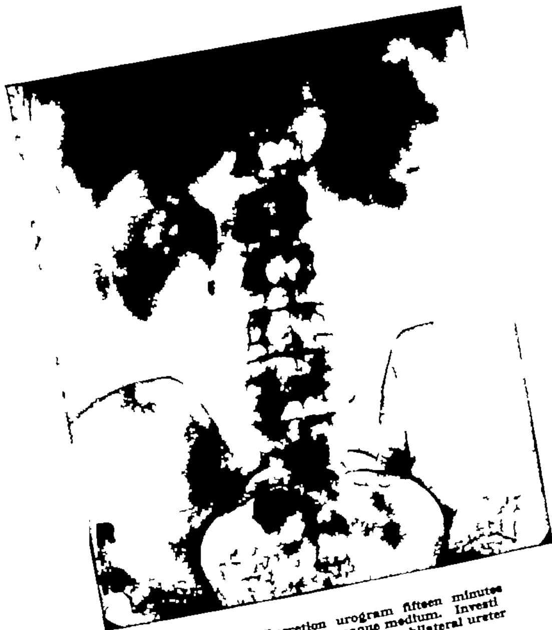


PLATE IX.—Excretion urogram fifteen minutes after the injection of an opaque medium. Investigation made over three years after bilateral ureter transplantation into the colon.

Publishers note. *We regret that the block showing the results of Sir Harold Stiles' operation (see page 1301) was damaged at a very late stage in production. As the original could not be traced in the limited time available, this illustration of a similar case (kindly supplied at short notice by Mr Norman Harrison, St. Bartholomew's Hospital) has been substituted. Sir Harold Stiles' case is illustrated in the previous edition of Modern Operative Surgery.*

fixed as before by the double flap method into one end of the wound remaining after cystectomy if this can be accomplished without tension otherwise this wound is completely sutured and the ureter is anastomosed at a higher level as in (1) After fixation of the ureter in the cystectomy wound and insertion of the para ureteral drainage tube several stitches traversing all bladder coats will be required to reduce the wound

Amongst alternative steps in technique adopted by Marion are (1) The ureter is exposed and separated transperitoneally (2) Where no intravesical procedure had been required the ureter is implanted through a stab-wound without the aid of an anterior cystotomy opening In such cases the bladder is drained through an intied catheter (3) A catheter is passed up the ureter and left *in situ* for a fortnight to drain the kidney it will leave the bladder either by an anterior cystotomy opening or by traversing the urethral catheter

(b) **Transplantation of the ureter into the colon (uretero-sigmoidoscopy)**—Amongst the early pioneers to endeavour to divert the urine from the ureter to the bowel was Simon (1851) who by passing a thread suture between the ureter and the rectum caused a fistula between these structures However it is Chaput to whom credit is due for the origin of the method which is now frequently adopted and is to-day known as the Coffey operation

Chaput in De l Abouchment des Uretères dans l Intestin * described experiments upon dogs and operations upon human subjects giving as his indications for the latter the ureter injured too high up for implantation into the bladder exstrophy uretero-vaginal fistula vesico-vaginal fistula certain cases of tuberculosis and cancer of the bladder as a preliminary to total cystectomy The operation is one of necessity not of choice and is only done when nothing else can be offered to preserve the kidney function The ascending or descending colon was preferred the open end of the cut ureter being sutured by end to-side anastomosis to the bowel If the ureter was narrow its terminal inch was buried in the bowel wall by placing a series of sero-muscular sutures (comparable to a Witzel gastrostomy) He recorded a number of successful results Stiles† successfully implanted the ureters in two children suffering from ectopia, and we are grateful to the late Sir Henry Wade and the late Sir Harold Stiles for permission to show a recent excretion urograph of one of these cases 20 years after the operation (Plate IX) the almost perfect anatomical and physiological state is apparent and reflects the excellent functional result this patient has enjoyed for over a quarter of a century ‡

Stiles method differs from Chaput s in that the open ureter is invaginated through the bowel opening by a catgut suture threaded to two needles which transfix the bowel wall from within out when the suture is knotted the ureter is drawn into position The terminal inch

* *Arch. gen. de M d* January, 1894 clxxiii, 1
† *Surg Gyn and Obst.*, Aug., 1911, xiii, 127
‡ *Edin. Med. Journ* 1939 xlvi, 61



Fig 997 —Ureteral implantation into bowel (Coffey's method) incision of muscular coat.

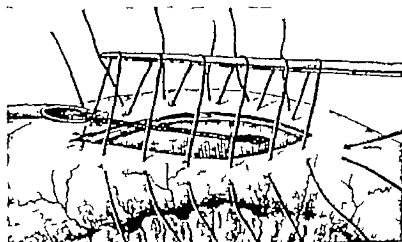


Fig 998 —Ureteral implantation into bowel (Coffey s method) end of ureter being drawn through opening in mucous membrane.

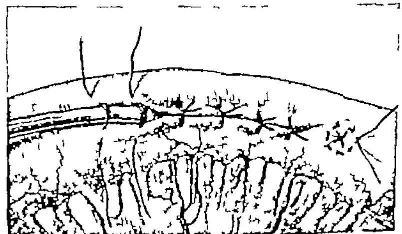


Fig 999 —Ureteral implantation into bowel (Coffey s method) tying bowel sutures.

of ureter is embedded in a longitudinal furrow in the bowel wall as in Chaput's operation Grey Turner modified this method embedding the ureter in an oblique track formed by the folded-over bowel wall He described 17 operations performed for ectopia vesicæ Seven years later he was able to show pyelograms of several of these cases † Many of his patients are now alive and well one 86 years and one 82 years since operation and some have undergone successful pregnancies.

Coffey's operation ‡—This operation aims at making the ureter travel for some distance beneath the intestinal mucous membrane before opening into the lumen of the bowel The ureter is freed as far as necessary double clamped divided cauterized and the lower stump ligated (Figs 997–999)

Four traction stitches to put the bowel on the stretch are inserted and grasped by forceps An incision 1½ in long is made through the seromuscular coats in one of the longitudinal bands The ureter end is transfixed by a curved intestinal needle carrying a fine catgut suture The suture is tied leaving two long ends If the Mayo method (*vide supra*) is adopted one end is cut to a 8 in length threaded on a coarse needle which is passed blunt end first up the lumen of the ureter and withdrawn leaving the stitch end *in situ* Otherwise the two ends are left long and threaded on two curved intestinal needles The mucosa is stabbed at the lower end of the bed and through the hole thus made the stitch-carrying curved needle enters the bowel lumen The needle emerges ½ in. below the stoma unthreaded and the ends tied, bringing the ureter neatly into place. A series (6 to 8) of sero-muscular stitches buries the ureter in the bowel wall the alternate ones commencing at the lower end picking up the outer coats of the ureter These sutures were actually placed in readiness in the original Coffey technique before constructing the ureteral bed A second reinforcing series of sutures buries the ureter still further and consolidates the anastomosis The peritoneal gap through which the ureter was dislocated is closed and the bowel is attached over it by sutures thus preventing a twist or kink of the ureter

Coffey has further developed this operation by thorough cleansing of the lower bowel and by placing a specially prepared catheter with rubber cuff in the ureters with the intention of preventing ascending infection in the early stage of convalescence as well as to ensure easy escape of urine from the kidney which without the ureteral tube would be obstructed by œdema in the ureter (the Coffey No 2 operation) These tubes which were subsequently modified by Kidd are brought outside the anal orifice They tend to become detached about 10 days after operation by which time risk of infection at the union will have passed. For the detailed description of these operations and a third modification the reader is referred to the original

* *Brit Journ. Surg* July, 1929 xvii, 114.
† *Ibid* Jan 1936, xxiii, 540
‡ *Journ Amer Med. Assoc* Feb. 11 1911 lvi, 397

article by R C. Coffey * or to the Medical Annual 1930 p 587 as well as to subsequent contributions by Nitch, B J Ward, and Walters.

Grey Turner's operation.—(*See* Fig 1000) Coffey's technique has been much simplified of late years and indeed there is a tendency to return to the simple end to-side anastomosis originally described by

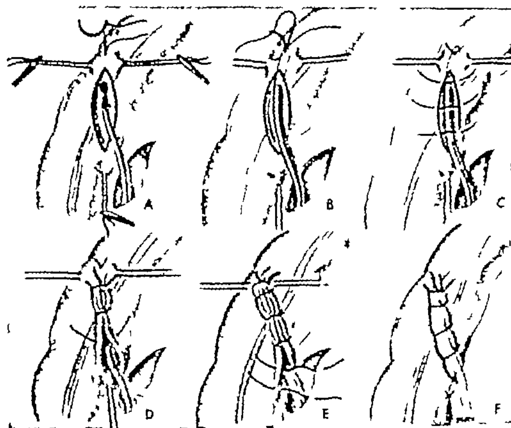


Fig 1000 —Uretero-colic transplantation. Grey Turner's method.

A, Three guide sutures have been introduced. The ureter being laid in its submucous bed, the fixation stitch has been passed through the bowel wall half an inch below the lower end. B, Fixation stitch taking a secure hold of bowel wall. C, Fixation stitch tied, sutures in position in muscular coat. D, These sutures tied. E, Fixation stitch buried, Lembert sutures taking up edge of parietal peritoneum. F, Completion. Notice that ureter passes directly from extra-peritoneal bed into bowel without kinking. The guide sutures have been removed.

Chaput (p 2801) Some surgeons have maintained that the submucous bed does not act as a valve-producing mechanism and may lead to stenosis of the lower end of the ureter leading to the slow onset of uræmia. We are not convinced of the truth of this statement but we do advise a very simple technique as advocated by Grey Turner † The bowel is prepared by the administration of sulphasuxadine for 5 or 6 days in large doses and an enema is given the day before the operation. Vigorous daily lavage for a week or 10 days is quite un necessary A pre-operative intravenous pyelogram gives an excellent idea of differential renal function and warns the surgeon of the presence

* Surg Gyn. Obst., 1928, xlvii, 603
† Brit Med. Journ 1943, ii, [illegible]

of any congenital abnormality A general anæsthetic combined with curare may be used for the operation With the patient in the Trendelenburg position a vertical midline incision is made below the umbilicus the intestines are packed away and the cæcum and upper rectum fully exposed The right ureter is implanted first and is easily recognized by its position and vermicular movements The point of implantation is selected about 1 to 2 in from the bottom of the recto-vesical pouch The ureter is exposed by incising the parietal peritoneum picked up and cut across The lower stump is ligated. The upper free end is carefully separated by blunt dissection for not more than about 2 in and the small ureteral vessels preserved The technique is similar to the one described as Coffey s first operation except that a short submucous bed obliquely across the bowel is prepared. It is most important to ensure complete hæmostasis in this bed before introducing the ureter and suturing If this is not done a hæmatoma around the lower end of the ureter is likely to develop After introducing the ureter and tying the fixation suture it is buried by not more than three interrupted sutures through the serous and muscular coats but not picking up the ureteral wall. Any more sutures tend to constrict the ureter at the point where it enters the colon and this is a fatal error of technique. The right ureter having been implanted on the right side of the rectum the left ureter is similarly isolated and can be implanted on the left side or alternatively may be conducted through the meso-colon to the mesial aspect of the bowel This allows apposition with less tension After each anastomosis has been completed the edges of the incision in the parietal peritoneum through which the ureter emerges are sutured to the serous coat of the bowel about ½ in away from the site of entry of the ureter The effect of this is to draw the bowel to the ureter and so lessen tension on the latter and to extraperitonize the anastomosis as a safeguard against peritonitis due to leakage In cases of ectopia vesicæ and other simple conditions particularly in children it is generally advisable to implant one ureter at a time In malignant cases both ureters are generally implanted at the same time but some surgeons prefer to implant one ureter and then perform the total cystectomy and implant the other ureter as the second operation When a double ureter exists on one side the two are generally included in one fibrous sheath and are easily isolated and laid in the bed as one ureter No tubes or splints are necessary in the ureter A rectal tube is left *in situ* for a week or so after the operation and the administration of chloromycetin is a useful prophylactic against renal sepsis

Cordonnier* and others notably in the U S.A have recently advocated a technique which they claim is less likely to be followed by stricture formation The ureter is isolated and divided in the usual way A small opening is then made in the bowel and by a few interrupted sutures an end to-side anastomosis is performed. Firstly the

* Surg Gyn Obst 1949 lxxviii, 441.

mucosæ of ureter and colon are united and then this line of sutures is inverted by a second layer uniting the peritoneum of the colon to the muscular wall of the ureter No attempt is made to invaginate the ends of the ureter into the bowel lumen Sandrey and others at St Peter's Hospital have combined end-to-side anastomosis with invagination of the ureter One of the sutures forming the mucosa-to-mucosa layer is left long threaded on a needle and the ends are then passed into the bowel and out through its wall about ¼ in. from the site of anastomosis. By tying this suture the effect is to invaginate the anastomosis slightly It is too soon yet to be able to state whether this technique is more or less likely to end in stricture of the lower end of the ureter than Grey Turner's technique In our opinion it is certainly an easier technique to use for a very dilated ureter Cordonnier claims that the advantages of this method are —

(a) Minimal disturbance of the ureter from its bed is less likely to lead to sloughing

(b) Mucosa-to-mucosa suturing and the absence of a submucous tunnel is less likely to lead to stricture of the ureter

(c) Extraperitonization of the anastomosis is a guard against peritonitis.

He reports 26 cases with no mortality and immediate diuresis in all but one

Riches operation.—In this operation each ureter is exposed extraperitoneally by a separate oblique inguinal incision. After dividing the ureter low down in the usual way the peritoneum is opened and a loop of pelvic colon or upper rectum brought out and extraperitonealized by suturing the edges of the peritoneal incision to the peritoneum of the bowel. The ureter is then implanted by making a short submucous tunnel in the usual way Riches states* that the right ureter should not be implanted into the cæcum owing to the risk of a serious upset of water absorption over the ensuing few months which in many cases has led to the death of the patient.

Post-operative complications. **Anuria.**—It is not uncommon for anuria to occur for as long as 48 hours after operation. If it continues after this time the outlook becomes increasingly grave. The commonest cause is tight suturing where the ureter enters the bowel wall post-operative œdema will then make the block complete. After making sure that the rectal tube is clear 5 per cent. glucose saline should be given by intravenous drip followed if necessary by a litre of 4 8 per cent. sodium sulphate. If these measures are ineffective by about 72 hours after operation then a nephrostomy should not be long delayed. It is often difficult to decide on which side to perform the nephrostomy Occasionally pain on one side or tenderness or a palpable kidney will give the lead but more often than not one kidney is drained to try and tide the patient over till the other recommences its secretion.

* Trans. Med. Soc. Lond., 1947 lxv 215.

Ileus.—A varying degree of abdominal distension is always present post-operatively and if this is followed by vomiting intravenous drip saline and gastric suction should be commenced Ileus which does not readily respond to this treatment is of very grave significance.

Peritonitis.—This is due to leaking at the site of anastomosis and is a grave complication It is difficult to diagnose in the early stages from true ileus but deficient drainage per rectum and some lower abdominal tenderness may indicate the true state of affairs. Later signs of free fluid may be detected The wound should be reopened and drainage established. If for any reason one can be fairly certain which side is leaking then nephrostomy on that side should be performed.

Burst abdomen.—Many surgeons have found this to be a troublesome complication in a number of cases It is commonest in malignant cases and is probably due to the combination of the poor general state of the patient and the post-operative abdominal distension. We cannot stress too emphatically the importance of careful suture of the wound after the operation including well placed tension sutures if the incidence of burst abdomen is to be reduced. Some surgeons use stainless steel wire to suture the wound, but we have not found this of any greater value than catgut with silkworm tension sutures

Urinary fistula.—We have found this more common after the extraperitoneal type of operation Sometimes the fistula may continue to discharge for weeks and even months but will eventually close Continuance after this would indicate the presence of a stricture at the site of anastomosis It may be possible to pass a ureteric catheter past the stricture either upwards or from above but in most cases reimplantation will be necessary

Ascending infection.—Careful suturing and operative technique and pre-operative sterilization of the bowel have done a great deal to eliminate this complication. Pyelonephritis after the operation is treated by giving chloromycetin and/or aureomycin and if a pyonephrosis should develop nephrostomy may be necessary

Achloraemic acidosis.—This complication is more common than was previously thought It is characterized by excessive thirst, muscular weakness and finally increasing coma. It is probably due to the selective reabsorption of chloride from the colon If it develops chloride intake is limited sodium bicarbonate is given by mouth or intravenously and the rectum is kept emptied by an indwelling rectal tube.

(c) **Transplantation of the ureters into the ileum (Ileo-cutaneous ureterostomy)**—The frequent occurrence of varying degrees of acidosis and ascending renal infection following implantation of the ureters into the colon has of late years caused this operation to be regarded with disfavour in some clinics Implantation into an isolated ileal loop has been used as an alternative to uretero-sigmoidostomy

Through a lower abdominal incision the ureters are divided in the usual way below the pelvic brim and the left one is passed through the pelvic mesocolon to lie on its medial side. Annis *et al* * recommend an oblique lower abdominal incision as being less likely to disrupt after operation The anterior sheath of the rectus is divided obliquely commencing below in the midline and the rectus muscles retracted laterally A loop of ileum 8–12 in. long is selected within about a foot of the ileocæcal valve The mesentery to the loop is divided for about two inches from the bowel taking care to leave as wide a mesenteric pedicle as possible The continuity of the alimentary canal is restored by end to-end or side-to-side ileo-ileal anastomosis The isolated loop is then tacked down to the pelvic brim on the right so that the distal end can conveniently be brought out in the right iliac fossa. The proximal end of the loop is securely closed and then the ureters implanted at convenient places along its length. This may be done by the Coffey Stiles or mucosa to-mucosa technique observing the same precautions against kinking and over tight suturing as in colonic implantation

Annis Hunter and Wells report having performed this operation combined with total cystectomy in one stage with only 4 post-operative deaths in 21 cases They also recommend this method of urinary diversion in all cases as an alternative to the older colonic transplantation Bricker (1952) † in a series of 28 patients found no renal dilatation after this operation when it did not previously exist and when dilatation was present before operation it improved afterwards

The operation does not entirely eliminate the occurrence of some degree of hyperchloræmic acidosis and has the disadvantage that the urine not being controlled above a sphincter the patient must always wear an ileostomy bag

(*d*) **Transplantation of the ureter to the skin.**—This operation is indicated where no other form of transplantation can be entertained owing to the pathological state of the ureter or to its reduced length renal deficiency or a poor general condition. As a means of permanent diversion of the urine it has advantages over the only alternative nephrostomy The primary object is to give relief from a chain of burdensome bladder symptoms such as are common in advanced tuberculosis or malignancy Relief of intra renal tension and ascending sepsis may establish such constitutional improvement as to prepare for a later total cystectomy Iliac implantation is preferred to lumbar as the ureter is less liable to kinking the blood supply to the duct is better maintained drainage apparatus is more satisfactorily applied and the orifices can be seen and attended to by the patient. The lumbar site is sometimes unavoidable from the shortness of the available ureter

In the iliac operation the ureter is freed extraperitoneally as low as possible through a muscle-splitting inguino-iliac incision divided

* Annis, Hunter and Wells, 1954, *Brit. Journ Surg.*, xlii, 290
† Bricker E. M., 1952, *Surgery* 32, 372

ligated cauterized and the upper end is conducted obliquely through the muscles some points of suture being placed between them and its outer coats. A large ureteric catheter or fine rubber tube is passed up the ureter into the pelvis of the kidney and the ureter is fixed to the skin one inch from its cut end the redundancy is to allow subsequent contraction It is important to secure a greater length of ureter than the distance to the new opening seems to require to avoid tension Sloughing of the last two inches constitutes the main danger of this operation It is essential to avoid kinks in the ureter s course it may therefore be better to conduct it through a separate stab incision

The ureteral tubes are at first drained into bedside receptacles subsequently when the case is ambulatory into rubber bags held by a belt It is preferable to preserve tube drainage than to apply rubber caps to entrap the urine Permanent tubes are well tolerated and may often be allowed to remain in 4 to 6 weeks without changing

URETERAL INJURIES AND THEIR TREATMENT

The ureter is injured by —(1) gunshot wounds (2) perforation by a calculus (3) surgical operations (4) obstetrical complications and (5) radium therapy

1 **Gunshot wounds.**—We have come across a few cases in war wounds and these have been recognized by a urinary fistula shown to be unconnected with the bladder by the fact that a coloured solution introduced through a urethral catheter did not appear in the wound discharges. Chromocystoscopy and ureteral catheterization showed the side affected in the 1914-18 War to-day excretion urography is the chief aid to diagnosis. Nephrectomy is usually necessary to bring about healing of the fistula.

2 **Perforation by a calculus.**—The condition is very rare and follows ulceration The calculus escapes into the peri-ureteral connective tissue and causes abscess formation The ureter may heal spontaneously after drainage of the abscess and removal of the stone but a fistula is more likely to follow requiring nephrectomy

3 **Surgical operations.**—In the course of operations especially gynæcological performed deep in the pelvis one or both ureters may be divided ligated, crushed by artery forceps or the blood supply may be cut off by block dissection for malignant disease as for example in the Wertheim hysterectomy and in perineal excision of the rectum One of us (H K V) has seen a case of perforation of an apparently normal ureter by a 5F ureteric catheter passed at cystoscopy

4. **Obstetrical complications.**—These may follow either difficult labour where the ureter sloughs as the result of prolonged pressure of the fœtal head at the pelvic brim or the inclusion of the bladder base in the faulty application of forceps.

5 **Radium therapy**—Radium used in the treatment of cervical carcinoma in excessive doses may cause sloughing of the lower ends of the ureters the outcome of which may be a uretero-vaginal fistula. Smaller dosage can cause a low inflammation resulting in fibrous thickening stricture formation and hydronephrosis (T F Todd personal communication) We have twice had to transplant the ureters some months after radium therapy for carcinoma of the cervix There was almost complete blockage of the ureters but no sign of any malignant invasion One case is still alive after three years Deranged vascularity may be a sequel to ureters which have been so exposed and this may account for some failures in the operations of transplantation to the bowel or bladder

Ligation and other Surgical Injuries of the Ureter

Caulk and Fischer carried out experimental ligation of the ureters in 70 dogs. They found that the blood nitrogen showed a gradual rise even after the ligation of one ureter After nephrostomy there was often a further rise for 3 or 4 days followed by a drop to normal.

The ureter has been intentionally ligated in the course of operations in the hope that the kidney may atrophy as in certain cases of partial cystectomy where transplantations are unwarranted. Such ligations of choice are however not always successful the ureter may slough and a fistula form for which there is generally no cure other than nephrectomy Ligation may be successful in preventing a fistula the kidney however may not atrophy and a painful hydronephrosis later requires nephrectomy It is preferable to leave the ureter short of the bladder and provide adequate perivesical drainage (Swift Joly)

Accidental ligation of the ureter may have similar effects. Like crushing or division it may not be recognized at the time of operation. One of us (J E) removed a huge hydronephrosis 20 years after a hysterectomy the patient said she had suffered great pain in her kidney region in the first three weeks after her first operation but the pain had gradually subsided It was proved by ureteral catheterization that the ureter was obstructed an inch from the bladder Accidental bilateral ligation constitutes an urgent problem which comes within the province of the urological surgeon By the time he is consulted 36 to 48 hours after the operation catheterization will have proved unquestionable suppression If catheterization of the ureters reveals ureteric obstruction 1 to 2 in above the ureteric orifices operation is imperative its nature will depend upon the capacity of the patient to withstand either a long and complicated abdominal operation or rapid bilateral nephrostomy According to Leon Harman* statistics have shown better results from abdominal exploration a number of successful cases of deligation are recorded. The previous laparotomy wound is re-opened or a fresh paramedian incision made to deal with the cause of obstruction The ureters are dilated and

* Journ Urol., 1923, ix, 181

therefore easily recognized as they cross the pelvic brim Time will be saved if they are opened and a probe passed down to localize the exact site of obstruction Obstructing ligatures may be found and removed without fear of hæmorrhage If the ureters have been divided or crushed there is little prospect of local repair transplantation to the bladder should then be attempted Occasionally the ureters may be found intact but compressed by a large extraperitoneal pelvic hæmatoma its evacuation re-establishes diuresis

If recovery from operative shock does not warrant the risk of what may be a long difficult operation double nephrostomy should be rapidly performed The pelves will be found distended and nephrostomy is accordingly simplified indeed it may not be necessary to

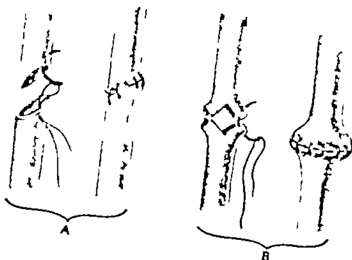


Fig. 1001 —Uretero-ureterostomy
A, Oblique anastomosis. B, T-shaped anastomosis.

dislocate the kidneys from their beds Cases were reported by Caulk* and E J Judd where micturition was automatically resumed evidently due either to absorption of the ligatures or to recovery from bruising Such a fortunate outcome is not to be expected and it would be wise to take the earliest opportunity of exploration and repair It is noteworthy that a bladder deprived of its normal contents is likely to develop severe cystitis from which ascending sepsis may reduce the ureter to a state unfitted for transplantation

When ligation crushing or division of the ureter is recognized during the course of an operation it is likely that the main operation has so reduced the patient that a further complicated procedure is not warranted The surgeon would then be forced to ligate or transplant to the skin In more favourable circumstances immediate repair should be attempted If the ureter is divided some distance from the bladder uretero-ureteral anastomosis can be carried out preferably by the end-to-end method (Fig 1001) and such union is made easier if performed

* Caulk and Fischer *Trans. Amer Assoc of G-U Surg* 1915 x, 72.

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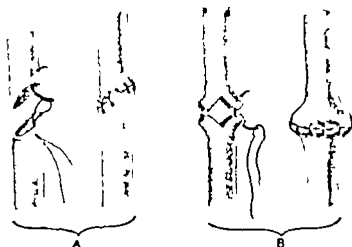


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on a ureteric catheter or length of capillary rubber tubing the upper end is passed up to the kidney and the lower end into the bladder from which it is removed in the course of a day or two by an operating cystoscope. The catheter while in residence will assist renal drainage and overcome such obstruction as may be caused at the union by oedema. If the division is too low for anastomosis probably sufficient length of ureter remains to allow bladder transplantation without undue tension

In practice the majority of operative ureteral injuries are not recognized during the operation especially where there is merely a bruising or possibly nothing more than interference with the blood supply In these cases leakage of urine takes place into the pelvic cellular tissue giving rise to an abscess which tracks either to the skin incision or to the vagina. In either case there is an escape of pus followed by a persisting urinary fistula. Spontaneous healing of such a fistula may take place one or two months should therefore be allowed to give sufficient opportunity for it to close. If it heals ureter catheterization and intravenous pyelography should be carried out at intervals so that if a stricture forms it may be recognized and treatment instituted at an early date

Where the fistula persists intravenous pyelography and ureteric catheterization must be employed to determine which ureter is injured and at what level If the ureteric catheter should pass beyond the site of injury up the ureter it should be left *in situ* for a few days The nature of operative cure of the fistula will be decided upon the data provided it is seldom possible or wise to perform any operation other than transplantation to the bladder or nephrectomy

Uretero-Ureteral Anastomosis

Repair of ureteric injuries in the lower pelvis are seldom sufficiently within reach to permit the complicated technique of uretero-ureteral anastomosis At higher levels there is every prospect of success Stenosis is the chief complication to be avoided to prevent this the following factors should be taken into account (1) The urine passing down the affected ureter should be as sterile as possible, otherwise ureteritis may be set up at the anastomosis (2) The anastomosis should be made in such a way that the slight stenosis inevitable after the operation shall not materially diminish the calibre of the ureter (3) As far as possible stitches should not be passed through the mucous membrane as they tend to act as foci for calculi and for micro-organisms. (4) Retroperitoneal drainage to the anastomosis should always be adopted for the first few day[illegible] leaka[illegible] of urine will set up a diffuse chronic peri-ure[illegible] subseque[illegible] stricture or perhaps peri ureteral abscess with[illegible]

The *suture material* in all plastic operations [illegible] fine catgut 6/0 introduced on atraumatic

The [illegible] anastomosis can be performed [illegible] end [illegible] end-to-end, [illegible] end-to-side or end-in-side. Each of these has been tried [illegible] on human beings or on animals.

(1) **End-to-end anastomosis.** (i) *Transverse*.—This was the first type of operation tried: the cut ends are sutured together with interrupted sutures of fine catgut passing through the outer and muscular coats only. There is no loss of length but a danger of stenosis.

(ii) *Oblique*.—This method was devised by Bovée* and is probably the best in the majority of cases. The upper and lower ends are cut obliquely and the cut ends united by single interrupted sutures with a few mattress-sutures interposed; the majority of the sutures pass through the outer coats only (Fig. 1001 A). This method entails only a small loss of length and stenosis is compensated by the oblique section.

(iii) Perhaps the method where stenosis is least probable is that shown in Fig. 1001 B. T-shaped flaps of both ends of the ureter are made by linear incisions for a short distance. The ends are then sutured as shown.

(2) **End-in-end anastomosis.**—This method devised by Pozzi† has given good results in animal experiments. The upper end is brought into the lower which may be split to increase the calibre. Two fine needles armed with two fine sutures are passed through all the coats of the upper end; the needles are passed almost side by side from within outwards through the lower end. These sutures being tied, the upper end is invaginated into the lower; the junction is closed over by interrupted sutures. This method should only be used where the ureter is dilated.

(3) **End-in-side, or lateral implantation.**—This method was devised by Van Hook‡ and is somewhat similar to the end-in-end method, except that the upper end is invaginated into an incision in the side of the lower; the kidney end of the lower part is ligated and the lower end of the upper is slit for a short distance. This method requires more length of ureter than the others but, where there is a sufficiency, gives good results.

Results.—Alkane§ collected 60 cases of ureteral anastomosis published since 1886. He found 48 were cured, 9 were cured after a temporary fistula and 8 died. The best results followed end-to-end suture with invagination. In every case which survived there was a slight degree of hydro-ureter or hydro-nephrosis. Petersen|| in studying 72 cases of ureteral anastomosis found a mortality of 5.5

* *Ann. Surg.*, 1900, xxxii, 165.
† XIX Cong. de Chir. Paris, 1906, p. 190.
‡ *Journ. Amer. Assoc.* 1893, xx, 911, 963.
§ *Folia Urologica*, 1908, ii, 280.
|| *Surg. Gyn. Obst.* Aug. 1920, xxxi, 132.

is of long standing as after suprapubic cystostomy the peritoneum is more firmly attached. Occasionally it may be firmly adherent to the back of the symphysis pubis.

Care and use of endoscopic instruments.—The modern instruments are delicate and expensive but when fairly treated can give years of troublefree service. A cystoscope may be damaged through lack of knowledge or through carelessness. The telescope may fall out of the sheath if not properly locked into position It can be allowed to roll off a table. Any part of the instrument may be damaged if incorrectly replaced in its box and the lid is forced down, and the telescope can be twisted or bent if excessive force is used in inserting it into the sheath. When handling a cystoscope or endoscopic instrument it is always better to hold it by the outer end and never by that part which is to enter the bladder There are special forceps T shaped, (St. Peter s pattern) which may be rubber covered and are designed to hold the sheath but it is safer if the surgeon himself picks up the instruments out of the tray by hand

Most modern irrigating instruments are fitted without valves and the flow of water is controlled by a tap or stop cock. The most likely cause of light trouble is usually found in the leads or in the power supply whether it be battery box or transformer It is always necessary to have spare leads available with well fitting contacts. Light contacts may flicker in instruments with a rotating collar if the contacts are allowed to become dirty or if the stud gets sticky and does not press evenly on the rotating ring

The use of an earth free transformer as a source of electricity has considerable advantage over a battery box since there are less temporary contacts to work loose and also the voltage of any setting of the controls is constant. A lamp that is nearing the end of its life requires an increasing current so that if the setting on the rheostat has to be altered the bulb is liable to burn out With a battery box the rheostat setting varies with the resistance of the bulb and the voltage of the battery When the battery is running down the rheostat setting will have to be increased even if the bulb is in good condition. The cystoscope bulbs in common use are rated at 6 volts and are nearly all of the cartridge type. The bulb is inserted into the tip of the cystoscope and contact is made by a collar which fits lightly into the end of the cystoscope whilst the second contact is a platinum wire which presses on the extreme tip of the instrument.

Adequate contact must be made and may be interfered with if the sleeve of the cystoscope is dirty or the wire on the lamp is squeezed flat. In order to obtain the best possible light the current is increased until the filament can no longer be identified and the light changes from yellow to white.

Sterilisation of cystoscopes.—The best method of sterilisation is by boiling Only a few cystoscopes are so made that they can be boiled without damage The majority of instruments cannot be

sterilised in this way without breaking the cement in the telescope after which water enters the lens system and obscures vision During boiling the cystoscope should be protected by the special perforated metal container in which it was supplied In such a box the instrument may be safely dropped into a boiling steriliser and left in for two to three minutes Sudden cooling reduces the pressure inside the telescope however and may crack the cement and allow moisture to enter the lens system It is a great advantage to be able to use a boilable instrument after it has been used on a tuberculous or heavily infected case

Non boilable instruments may be sterilised in an electrically heated formalin cabinet although many clinics rely on pre-operative immersion of the instrument in various solutions When relying on sterilisation by immersion the solution should be bactericidal should be relatively innocuous to the urethral mucosa and it should not corrode the plating of the instruments

The cystoscope must be cleaned thoroughly with soap and water immediately after use. If there has been any contamination by blood during the examination it may be necessary to use a soft scrubbing brush and also to swab out the inside of the sheath to remove all traces of material on which bacteria can grow

Lubricants.—Liquid paraffin is a good lubricant but it tends to smear the lens so that the view may be obscured A water soluble proprietary jelly is probably the most satisfactory lubricant for routine use.

The telescope —If the view through the telescope is indistinct the eye piece should be wiped first Should this not clear the field the objective window is wiped with a swab wrung out in spirit which will remove any grease or lubricant which may have been left on the lens The commonest cause of the field becoming suddenly obscure is when hot humid, expired air from the operators breath has been deflected by a mask on to the cold lens of the telescope. A persistent mistiness after eliminating these causes means moisture in the telescope which will require the attention of the instrument maker

Local anaesthesia.—The majority of cystoscopic examinations can be carried out adequately under local anaesthesia. An important contra indication is when the bladder is inflamed so that its capacity is markedly diminished. Under these circumstances a good examination will be extremely difficult Another contra indication is when there is a reasonable probability that something further will have to be done such as litholopaxy, biopsy of a tumour or a bimanual examination

When using local anaesthesia there are two cardinal rules Firstly the anaesthetic solution or jelly should be distributed evenly throughout the urethra and secondly it should be allowed sufficient time to act Although the Canny Ryall solution of cocaine and soda bicarbonate is extremely effective and economical, it is not so stable nor so con

veniently dispersed as the Lignocaine urethral jelly. This is both an anaesthetic and a lubricant and is packed in 15 ml. tubes sufficient for one patient. With the ordinary nozzle, the anterior urethra is filled and the jelly is massaged through into the posterior urethra. A special nozzle is made (Eynard) which can be attached to the Lignocaine tube and which allows the jelly to be inserted directly into the posterior urethra. The jelly should be left to act for 5 minutes by the clock.

Position for examination.—The extended lithotomy position has grown in favour during recent years. This position with the hips flexed to about 45° is not uncomfortable for the patient and there is no difficulty in inserting a cystoscope, although when the lithotomy position is exaggerated instrumentation can be difficult.

In this position it is possible to inspect the anterior wall of the bladder by depressing the eye piece of the cystoscope, a part of the bladder which is often incompletely examined if the examination is made with the patient lying flat.

This extended lithotomy position is probably easier for the operator and is the position of choice when endoscopic resection is contemplated. Some surgeons however still prefer to examine the patient in the supine position with a pillow under the buttocks when the examination is being made under local anaesthesia as it is sometimes less embarrassing for the patient.

Ureteric catheterization.—Ureteric catheters can now be obtained made of plastic material which can withstand repeated boiling. There is considerable risk of causing an infection of the upper urinary tract by the passage of a catheter which is not sterile. Boilable catheters should therefore be used and they are sterilised with the stilette in situ otherwise the lumen may be blocked by old blood clot or debris.

After use the catheter should be syringed with water to remove any foreign material which may have entered it. A little liquid paraffin, which will prevent rusting, should be applied to the stilette and the latter is then passed along the ureteric catheter.

The greatest care must be taken to avoid injecting air up the catheter before or during the injection of the radio-opaque medium since an air bubble can mimic a non-opaque stone or a filling defect due to a small tumour.

The collection of a ureteric specimen for bacteriological examination must be undertaken with scrupulous care. A good container is made by attaching a rubber teat which has been perforated, to the end of a small specimen bottle. These are autoclaved before use and the end of the catheter is inserted through the perforation in the teat and the bottle is strapped to the appropriate thigh.

Cystotomy* and cystostomy.—The operation of cystostomy has been performed much less frequently of recent years since it is widely accepted that many cases of chronic retention are best treated by an

operation of election for removal of the obstruction without preliminary drainage Furthermore urethral catheter drainage under proper conditions is simpler is usually as safe and is more comfortable than by the suprapubic route

The exposure of the bladder wall in order to insert a tube may be quite an elaborate surgical procedure in an obese patient and especially in comparison with the stab cystotomy using either a large trocar and cannula or the special Riches introducer and catheter (Fig 1002) But in many cases it is safer to expose the bladder in order to avoid

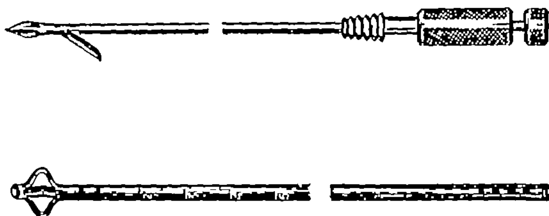


Fig 1002 —Riches introducer and catheter

entering the peritoneal cavity Whatever the method it is necessary that the bladder should be distended as much as possible and especially is this so if a blind method is being employed The optimum site for a suprapubic tube is halfway between the umbilicus and the symphysis With the tube in this position a suprapubic belt can be worn with reasonable comfort and with little or no leakage whilst there is sufficient space left to allow a retropubic approach to the prostate if it has to be removed at open operation.

The operation of stab cystostomy is usually carried out under local anaesthesia, the solution being injected not merely subcutaneously but also into and through the rectus muscle. A short transverse or vertical incision in the skin midway between the umbilicus and symphysis is carried down to the anterior rectus sheath This is divided



Fig 1003.—Trocar for cystotomy

in the mid line the edges retracted and the bladder identified. A trocar with cannula is then stabbed downwards and backwards to enter the bladder An excellent modification is that of Morson with a side channel and made of a size which will take a 24 F Malecôt tube. The trocar is withdrawn and the catheter on a straight introducer is inserted down the cannula

Riches method of Suprapubic Catheterization* is also useful. A very small skin incision is made at the highest point of bladder dullness or at the midpoint between the umbilicus and symphysis whichever is the lower. A local anaesthetic may be used. A special introducer with the 18 Charrière catheter stretched on it and well lubricated is passed in a downward and backward direction, making an angle of 45° with the abdominal wall. When the knife-point has been felt to enter the bladder and has passed for a further 2 in. the stretched catheter is released and the knife point is sheathed. By means of an introducer the catheter is then advanced to a suitable distance. The position of the catheter is maintained by a rubber shield which is strapped to the abdomen. The method is useful when the bladder is tense and bulging forward in the lower abdomen. The paralysed bladder is not easily punctured owing to its lax condition. The method is dangerous if there has been a previous operation upon the bladder or if for any reason there is a chance that the peritoneum may intervene as for example when a suprapubic drain has been used to treat peritonitis.

Perineal urethrostomy as a method of short term bladder drainage has been used in certain clinics in preference to an indwelling catheter. A simple method of performing this operation is to pass a soft rubber catheter with a narrow forceps of the curved Moynihan gall bladder type clipped to the distal end. The forceps follows the catheter until its tip comes to lie in the capacious bulb of the urethra. By rotating the forceps the points can be made to present in front of the central point of the perineum and an incision over this will make the forceps with the distal end of the catheter present in the wound. If the urethra is of narrow calibre this is a satisfactory method of drainage. A perineal urethrotomy can also be used as a preliminary step in endoscopic resection but for this a more formal exposure is required.

EXPOSURE OF THE BLADDER

The formal exposure of the bladder may be effected by either a transverse Pfaffenstiel approach or by a mid line incision. The selection of approach will depend on the operation intended, the transverse being excellent for certain procedures around the bladder neck but less adequate if the vault is the site of operation.

The Pfaffenstiel transverse incision is made in a skin crease about ¾ above the upper border of the symphysis. It is rarely necessary to make the incision longer than five inches. The rectus sheath is incised transversely but the lateral part of the incision is curved upwards away from the inguinal canal. The aponeurotic flap is then raised from muscle above and below and if necessary the lower flap can be divided down to the symphysis pubis. In the majority of cases there are well defined pyramidales muscles but they are variable, not always symmetrical and occasionally may be absent on one or both sides. The muscles are then separated in the mid-line and the thin

* Riches, E. W. *Lancet*, 1943, ii, 128.

layer of fascia transversalis deep to which lies the perivesical fat is exposed. This layer of fascia is split transversely the fat pushed upwards and the anterior surface of the bladder wall exposed It can usually be easily recognised by the rather criss cross fasiculated appearance of the muscle fibres running mainly in a vertical direction Perivesical veins which are occasionally quite large are usually encountered running close to the surface of the muscle Since this incision is rarely followed by a hernia it is the best approach when the operation is of limited scope and is well defined It is difficult to extend it vertically however and it should not be used when there is a possibility of intra peritoneal exploration or more radical surgery

The mid-line incision.—There is a greater risk of herniation in a mid line incision but it can be easily extended and is almost essential if the intervention is to include a laparotomy For cases of urachal or suspected urachal tumours when the urachus and umbilicus should be removed the mid line incision can be extended to include the umbilicus. The incision is made in the mid line and carried down through the linea alba or just to one side of it The rectus muscles are separated and the posterior rectus sheath present in the upper half is incised. The wall of the bladder is identified as in the previous

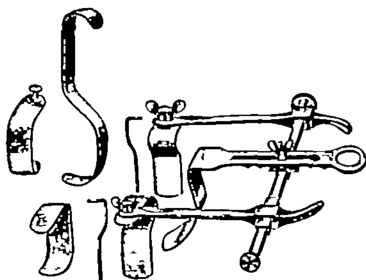


Fig 1004.—Thomson-Walker's self-retaining bladder retractor with anterior blade.

exposure and the transverse fold of peritoneum running in front of the bladder is pushed upwards out of the way before attempting to open the organ

The ease with which the bladder is recognised will depend on the degree of distension it is difficult to identify when empty and less easy to open because of its lax walls than is a full one

The choice of retractors will be influenced by the incision the transverse exposure being especially suited to the narrow bladed three

a defective anal sphincter In this case the choice lies between reconstruction of the bladder with a permanent cystostomy or transplantation of the ureters into an isolated loop of small intestine and the formation of an ileostomy The latter can be fitted with an adhesive bag which usually keeps the skin dry and the patient far more comfortable than with an uncontrolled fistula.

OPERATIONS FOR VESICAL CALCULUS

Preliminary considerations.—Primary stone in the bladder is of uncommon occurrence at the present time and before undertaking the treatment of a vesical calculus the case requires thorough investigation to determine the cause of its formation X rays of the bladder area will in most cases show the size and number of the calculi. A pure uric acid calculus is not opaque to X rays and if the photographs are not of good quality other slightly opaque stones may escape notice If an outlying opacity is seen there is a possibility that it is a stone lying in a diverticulum. An X ray will in most cases demonstrate a foreign body if a calculus has formed around it Cystoscopy will always confirm the presence of a stone When severe cystitis is present it may be necessary to wash the bladder for some time in order to obtain an adequate view and an irrigating cystoscope is then very helpful. Cystoscopy will also reveal complicating factors such as a mid lobe enlargement of the prostate other forms of bladder neck obstruction a vesical neoplasm or a diverticulum. An excretion urography should be employed to demonstrate the anatomical formation of the kidneys as well as their function and other tests such as an estimation of the blood urea will also be done. In many cases it may be of importance to estimate the blood calcium phosphorus and uric acid

Removal of stones through urethral instruments. — Small stones can usually be evacuated along a resectoscope sheath with a Toomey or other suction syringe. The sheath is first directed to the site of the calculus under vision using a right angled or fore oblique telescope. The bladder is filled the telescope and carrier are removed a Toomey syringe is attached to the end of the sheath and quick suction will usually remove any stone with a diameter smaller than that of the sheath An alternative to the Toomey syringe is the Ellik evacuator A small stone may be picked up and removed with crocodile forceps passed along a panendoscope

LITHOLAPAXY

Uncomplicated vesical calculi larger than 8 mm in diameter are usually best dealt with by litholapaxy but there are certain difficulties connected with this method and some selection of cases is essential. It is an operation of extreme delicacy and skill and requires experience in urethral manipulation and in the use of the lithotrite. Skilfully employed, it will save the patient a week or two of the convalescence

which follows a cutting operation but if the surgeon does not possess the necessary skill and experience and of course the necessary instruments lithotomy is the safer operation

Difficulties.—Difficulties depend on the stone and on the condition of the urethra prostate bladder and kidneys.

1 **The calculus** —(*a*) Very *large* calculi are better treated by lithotomy The grasp of a large lithotrite is up to about 5 cm and when the stone exceeds this in diameter litholapaxy should not be attempted although if one diameter of the stone is smaller this may be found by manipulation and the stone crushed Soft phosphatic stones of larger size may be crushed as the surface crumbles away under the nibbling action of the lithotrite

(*b*) *Hardness* of the stone rarely prevents litholapaxy but hardness combined with size will be a factor in determining its removal by lithotomy A stone may be too soft in which case it will clog the lithotrite

(*c*) An *impacted calculus* is unsuitable for litholapaxy A calculus impacted in the prostatic urethra which cannot be pushed back into the bladder a calculus in a diverticulum a calculus projecting from

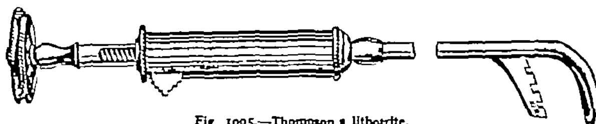


Fig 1005.—Thompson s lithotrite.

the lower end of the ureter or a calculus wedged behind the projecting lobe of an enlarged prostate should be removed by lithotomy

(*d*) *Multiple calculi* are best dealt with by lithotomy

2. **Urethra.**—A sufficiently capacious urethra is necessary for litholapaxy

A *narrow meatus* may be incised and a stricture cut or dilated. If there is a resistant stricture and especially if the stricture is complicated by fistula lithotomy is to be preferred to litholapaxy

3 **Prostate.**—Litholapaxy should not be undertaken when the prostate is enlarged unless the enlargement is to be dealt with endoscopically When however enlargement is slight litholapaxy may be attempted but the patient should be warned that it may be necessary to proceed with lithotomy Should retention of urine follow operation upon the prostate may ultimately be required

4. **Bladder** —(*a*) *Growth* of the bladder contra indicates litholapaxy

(*b*) A bladder with a *diverticulum* or with gross *trabeculation* and *sacculation* is unsuitable for litholapaxy This is for two reasons firstly the fragments may collect in the sacculus and form a nucleus for further calculus formation and secondly in the process of evacuation

the marked sudden increase of pressure in the bladder may rupture the sacculus and lead to pelvic cellulitis Furthermore a diverticulum or a trabeculated and sacculated bladder always indicates lower urinary obstruction which requires treatment and may best be dealt with by open operation

(c) A bladder may be so *contracted* as to contra indicate litholapaxy but if it holds four ounces of fluid a stone may be crushed.

5 **Kidneys** —Where there is a severe degree of infection especially if this involves the kidney or where the renal function is much impaired lithotomy and drainage of the bladder is a safer operation than litholapaxy

Instruments.—The instruments necessary for litholapaxy are a lithotrite and evacuating apparatus. Lithotrites of slightly varying construction have been introduced by Bigelow Guyon Thompson, Freyer and others Two patterns are in common use in the British Isles namely Thompson s (Fig 1005) and Freyer s modification of

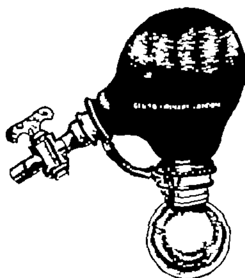


Fig 1006 —Freyer s evacuator

Bigelow s lithotrite. They must be of the best quality of steel and workmanship in order to obviate as far as possible the risk of breaking or bending during crushing Modern lithotrites which carry a telescope and light have been evolved. It is doubtful if the increase in size necessary to carry the telescope justifies their use

The two evacuators in common use are the Freyer and the Ellik (Figs 1006 1007) The Freyer evacuator cannot be sterilised by any method other than soaking in carbolic for a prolonged period. The Ellik evacuator can, however be boiled and it is also easier to see air bubbles should the evacuator develop a leak during the process of aspiration

Technique.—The suprapubic region should be shaved and prepared as for a cutting operation and the patient is anaesthetised The patient lies on a low operating table with a small sandbag under the buttocks This tilting of the pelvis allows the stone to gravitate to

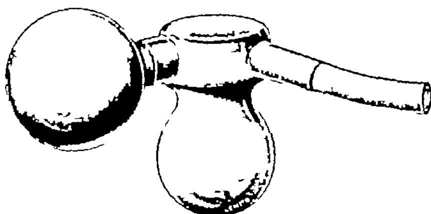


Fig 1007 —Ellik s evacuator

the posterior wall of the bladder away from the neck The thighs are abducted with the feet resting on a board at right angles to the table. The penis and scrotum are washed with antiseptic and sterile towels are arranged. The surgeon stands on the right of the patient and his assistant opposite The bladder is examined with the cystoscope in every case before performing litholapaxy and seen to be clear Four ounces of fluid are injected and the cystoscope is withdrawn. A lithotrite of suitable size is selected and if there is any doubt as to the calibre of the urethra bougies up to two Charrière sizes larger than the lithotrite are passed The lithotrite is well lubricated and introduced

The passing of a lithotrite is by no means easy in all cases and as it is of the utmost importance to avoid injury to the urethra the manipulation should be gently and carefully done The shaft of the lithotrite is held horizontally and about parallel with the right Poupart s ligament with the beak pointing downwards The penis is grasped with the left hand and threaded on to the lithotrite which is raised to the vertical the handle at the same time being swung medially so that the beak turns into the bulbous urethra and meets the opening of the membranous urethra. The instrument will with a little gentle manœuvring slide onwards by its own weight and the handle is allowed to sink slowly downwards in the middle line. Before this has reached the horizontal the beak will have engaged the internal meatus, and by pushing very gently onwards it will advance into the bladder Throughout these manœuvres the surgeon should be content to guide the instrument and follow it as its weight carries it in rather than to force its passage.

Grasping the stone (Fig 1008) is the next step The instrument is held at an angle of about 45° with the horizontal and the beak allowed to rest on the base of the bladder behind the trigone. The weight of

the lithotrite depresses the base of the bladder and the stone gravitates into this depression The handle of the female blade is firmly grasped by the left hand and the blades are unlocked by the right which then gently draws out the wheel or bulb at the end of the male blade thus parting the jaws of the beak. A moment s pause is necessary to allow the stone to drop down and come to rest between the jaws and on closing the foreign body is felt within their grasp The blades are locked and the stone is firmly held The lithotrite is now withdrawn for about 1 in to ensure that the bladder wall is not gripped the

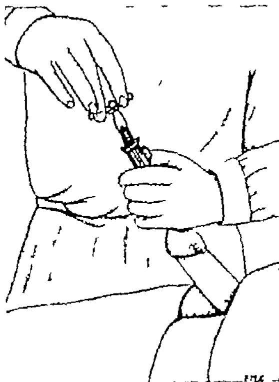


Fig. 1008 —Litholapaxy grasping the stone.

outer end is slightly depressed to raise the beak from the bladder wall, and the wheel of the male blade is firmly screwed home (Fig 1009) The resistance of a hard stone is at first considerable and when the blades are screwed home as far as possible, it may be necessary to wait a few seconds before the stone suddenly cracks with a sound easily heard by the operator Occasionally it may be necessary to release the stone and grasp it again in a fresh axis before the first splintering is accomplished The blades are now unlocked and the process is repeated until all the fragments are crushed.

During the whole of the crushing, the lithotrite is kept in the middle line of the body The left hand grasps the handle firmly and rigidly and is only removed when a change of position of the beak is required. The right hand controls the wheel or bulb which it locks when a fragment is engaged and frees when this has been crushed. When

no further fragment can be engaged in the blades the lithotrite is removed and a cannula as large as can be passed without damage to the urethra is introduced The fluid contents of the bladder rush

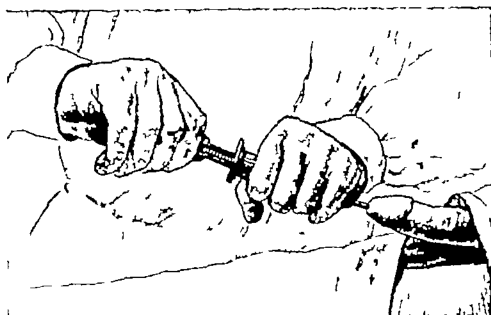


Fig. 1009 —Litholapaxy crushing the stone.

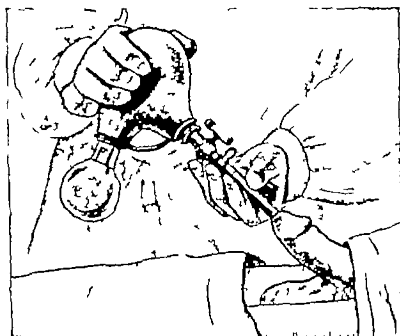


Fig 1010 —Litholapaxy removal of fragments by evacuating bulb and cannula.

out and may carry a little debris but the majority of the stone fragments have settled on the floor of the bladder and remain there The bladder is washed with several syringefuls of lotion and 4 oz of fluid is introduced The evacuating bulb filled with dilute antiseptic

solution is attached to the cannula and the stopcock is turned. There must be no air in the system as it impairs the force of inflow and suction. *The bulb is held so that the cannula is at an angle of 45°* and the beak of the cannula lies at the base of the bladder in the same position as that occupied by the beak of the lithotrite (Fig 1010). The left hand supports the cannula and the right grasps the rubber bulb and compresses it firmly and quickly. The fluid is forced out of the bulb into the bladder with a powerful current which sweeps the fragments off its floor. The grasp on the bulb is then quickly released and the fluid carrying the fragments before they have had time to settle *is sucked back from the bladder into the bulb* where the bits fall into the glass. The alternate systole and diastole of the evacuator is repeated until no more fragments appear.

After compression the bulb may refuse to expand. This may be due to mucous membrane having been sucked in by the diastole. A further squeeze of the bulb will free the mucous membrane, and the cannula is placed so as not to repeat this error of technique. It may be due to a fragment becoming impacted in the eye of the cannula, *often accompanied by an audible click. If it is too large to pass* the aspirating bulb is detached from the cannula and a stylet passed along the lumen and sharply pushed home. A rush of fluid shows that the fragment has been displaced into the bladder. Fluid (4 oz.) is again introduced into the bladder, the lithotrite re-introduced and the fragment crushed and evacuated. There may be a clicking noise at each diastole of the bulb due to the impact of one or more fragments too large to pass the cannula. In this event the process of crushing and evacuation must be repeated. *The most difficult fragment to pick up* with the lithotrite is a flat scale from the outer surface of a large stone.

Search is now made with the cannula in different parts of the bladder, compression of the bulb being made in each position but the cannula is always quickly turned so that the eye points upwards before suction is allowed. This manœuvre prevents the mucosa being sucked into the eye of the cannula. If any fragment is left it will either be swept into the evacuator or will be felt and heard to click against the cannula, and will necessitate re-introduction of the lithotrite. For small fragments at the end of a litholapaxy a smaller lithotrite may be used.

When no further fragments can be felt and debris no longer falls into the glass container, the lithotrite is removed and the bladder is washed out through the cannula until the fluid runs clear. A cystoscope is introduced (an irrigating pattern is much the best) and the whole of the interior of the bladder is inspected. Occasionally there may be bleeding sufficient to obscure the cystoscopic view and then a plain X ray should be taken of the bladder region to make sure that no fragment has been left behind.

If the operation has been carried out successfully there should be little more than a trace of blood in the wash. In such a case and where the bladder has been clean before the operation and there is no

enlargement of the prostate the patient may be returned to bed without a catheter in the urethra It is probably safer however to fix in a Foley catheter and this is especially so if the stone has been a large one and there has been a good deal of bleeding from an inflamed mucous membrane Where the urine is infected or if there is some enlargement of the prostate a catheter should be left in the urethra for forty-eight hours or longer and during this time the bladder may be washed with weak antiseptic solution In most instances litholapaxy including a preliminary and subsequent cystoscopy may be easily completed in less than half an hour

When a stone of moderate size has been crushed in a clean bladder the patient will be able to leave for home at the end of a few days but if the stone was large and urinary sepsis present a longer stay will be necessary

Complications.—The risk of rupturing a sacculus by the forcible use of a Bigelow s evacuator has already been alluded to as one of the contra indications to the operation (*see* p 2325) If the lithotrite was used in an almost empty bladder damage might very easily be inflicted. Apart from this if litholapaxy is carried out on properly selected cases according to the technique described, the bladder wall will not be damaged. The only likely complication besides hæmorrhage which should never be severe if the cases are properly selected is fever A rise of temperature following a rigor may occur after litholapaxy if infection is already present Pyelonephritis will be indicated by a rise of temperature and pain in the kidney region and the scrotum should be examined for evidence of epididymitis In a few instances retention of urine may follow removal of the catheter It is likely to be due to a minor degree of prostatic obstruction which has been increased by temporary œdema at the bladder neck following the instrumentation. A catheter should be replaced for a few days when the condition usually subsides Occasionally however some form of operation upon the prostate becomes necessary

Very rarely in spite of careful preliminary investigations a stone unsuitable for litholapaxy may be met with for example one containing a foreign body as its nucleus For this reason the instruments necessary for cystotomy should always be available and the patient warned of this possibility

Litholapaxy under Vision

Lithotrites which carry a telescope can be employed to crush stones in the bladder but the grasp of these instruments is not more than half an inch and for this reason the method can only be used for small stones Such instruments are necessarily much larger than an ordinary lithotrite with a grasp of the same dimensions and the risk of injury to the urethra usually outweighs the advantages obtained by the view

Lithotomy

Perineal lithotomy was the operation of choice before anaesthesia and asepsis but there is no place for it in modern surgery

Suprapubic lithotomy —This operation is performed for all cases of stone where litholapaxy is contra indicated and when the bladder has to be opened for a complication or co-existing lesion. The procedure is the same as for the operation of cystotomy (*see* p 2818) The size of the incision in the bladder will vary with that of the calculus in many cases a small opening is sufficient Through it lithotomy forceps (Fig 1011) are introduced and with these the stone is picked up and removed If however this is not easily effected it is best to enlarge the incision and introduce bladder retractors the stone can

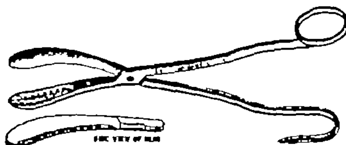


Fig 1011 —Lithotomy forceps.

then be picked up under vision. This procedure should always be employed if there are several stones or if being composed of phosphates they are unusually friable since it is of great importance that no stone or fragment should be left in the bladder itself or in the tissues outside it The bladder may be flushed with lotion from an irrigator suction being used to remove the fluid. In every such case and whenever there has been difficulty in making a complete cystoscopic examination the bladder should be thoroughly examined, retractors being introduced and the patient put in the Trendelenburg position if necessary It may be difficult to extract very large calculi from the bladder particularly if a portion extends into the prostatic urethra. An assistant by exerting upward pressure upon the perineum or with two fingers introduced into the rectum may assist in dislodging such a stone.

The operation may now develop into the removal of the prostate a wedge resection of the bladder neck or the removal of a diverticulum.

If the prostate is suitable for the retropubic approach and the stone has a diameter of less than two inches it may be removed through the bladder neck after the enucleation.

Vesical Calculus in Children

Litholapaxy —There are objections to litholapaxy in children in whom the urethra is very small and narrow and its mucous membrane delicate and easily torn Further the bladder is small and pear shaped so that the space for manipulation is confined Special instruments of small size are necessary and the surgeon should be provided with a series ranging from No 12 Charrière (6 English scale) No stone with a diameter of more than 1 in can be crushed in an infant

of either sex or with a diameter of ¼ in in a boy The cannulæ suitable for children vary from 12 Charrière (6 English scale) The small sized cannulæ should be short as the suction power is diminished by the small lumen The aspirator is used with the utmost gentleness and only a small quantity of fluid is passed into the bladder at each systole

The calibre of the urethra at different parts varies more in the child than in the adult The meatus and first inch and a half are the narrowest part of the urethra in the child Having passed this the lithotrite enters the bladder without further difficulty except for a slight hitch at the internal meatus The operation in children takes longer and there is more danger of leaving fragments behind but this can be avoided by care and experience If the lithotrite does not lie easily in the canal there may be difficulty in withdrawing and re-introducing the instrument For this reason special care should be taken to finish the crushing before withdrawing the lithotrite and this must be very thorough and the cannulæ used only permit the passage of small fragments Cystin calculi may be very hard and not at all friable or the fragments may cling to and clog the jaws of the lithotrite Therefore litholapaxy is usually contra indicated in this disorder in children and lithotomy should be substituted

Lithotomy—In infants and small children particularly males lithotomy is the operation of choice for the bladder is readily accessible. The bladder can usually be closed completely the first suture being a continuous one through all the coats the second of Lembert type to invaginate the first The abdominal wall is closed and a corrugated rubber drain is placed in the lower part of the incision in case there should be any leakage An in-dwelling catheter is not essential though most surgeons prefer to have one

OPERATIONS FOR FOREIGN BODIES IN THE BLADDER

A foreign body in the bladder is usually recognized by cystoscopy and radiography In some cases however these investigations will only show a calculus and the foreign body which forms its nucleus will be unsuspected. The dangers of litholapaxy in such instances have been alluded to on page 2325

1 **Cystoscopic extraction**—It may be possible to remove a small foreign body or one of narrow calibre such as a length of tubing or a wax taper through a panendoscope by suction or with grasping forceps

2. **Solvents.**—If the foreign body is of wax alone an attempt may be made to dissolve it Several solvents have been used but the most successful and least irritating are xylol and petrol. In using xylol a catheter is passed and 4 oz of water with 1 oz of xylol is run in and left for two to three hours This is slightly irritating for the bladder Petrol 1 oz in liquid paraffin 8 oz is used in the same way The wax in a taper may be dissolved by a solvent but the cotton wick usually requires to be removed with forceps through the panendoscope

3 **Suprapubic cystotomy**.—In the majority of cases it is necessary to open the bladder. A foreign body is often enveloped in a coating of friable phosphatic deposit and only by this route can the object be removed intact. If there is little infection the bladder may be closed and drained by a urethral catheter but otherwise a suprapubic tube is left in for a few days.

OPERATIONS FOR TUMOURS OF THE BLADDER

Diagnosis.—Before undertaking the treatment of a bladder-growth *careful examination must be made so that an opinion may be formed* on the character of the growth and its position, accessibility and spread. It should be remembered that almost all growths of this viscus are potentially malignant and to be controlled must be completely eradicated. Apart from the routine and bacteriological examination of the urine, there are four most important investigations which must always be performed :—

1. Cystoscopy.
2. Bimanual examination of the bladder and prostate.
3. Excretion urography.
4. Biopsy.

There is no doubt that the omission of any one of these examinations may give rise to an error in diagnosis or to incorrect treatment.

Cystoscopy.—The following points are noted :—

(*a*) The position of the growth or growths and their relation to the internal meatus and ureteric orifices.
(*b*) The number, if multiple, of growths.
(*c*) Whether the growth is pedunculated or sessile.
(*d*) The character of the surface, whether fronded, raspberry-like, smooth, nodular or irregular. Whether it bleeds easily. Is ulceration or necrosis, or *phosphatic deposit present?*
(*e*) Whether the mucosa surrounding the growth is normal or unduly vascular, roughened or œdematous.
(*f*) Evidence of infiltration of surrounding tissues as shown by œdema, by raised extensions from the base of the tumour or by other nodules in the adjacent mucosa.
(*g*) The existence of cystitis cystica, leukoplakia or other mucosal changes.

The *cystoscopic appearances* should be recorded in the notes by the surgeon himself and a bladder chart constructed immediately after the examination (Fig. 1012); this is most important for future reference because the follow-up in such cases often extends over many years. The posterior urethra should also be examined. It is an exception for a lesion to be found here at the first examination but after treatment, especially resection of the bladder neck, further tumours, possibly implantation tumours, may be observed in this region.

Biopsy—Small pieces of a tumour can be removed with the loop of a resectoscope or with the Cold Punch Special cystoscopic rongeur forceps such as Lowsley's Young's or Riches have been designed for obtaining material for histological examination. When only a small fragment of tumour is available for microscopic study the accuracy of the histological grade is often doubtful but when an adequate biopsy specimen is obtained this grading is rarely equivocal

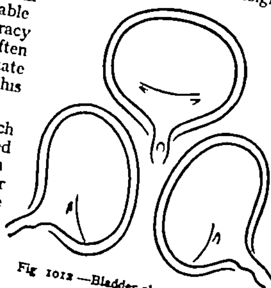


Fig 1012—Bladder chart for record keeping.

Bimanual examination—Much valuable information is obtained from a bimanual examination which should be conducted under full anæsthesia except in the thin and co-operative patient A papilloma is not usually felt in this manner unless it is very large and then only as a soft mass. An infiltrating growth which has invaded the musculature is almost always palpable except in the very obese patient Involvement of the bladder wall and extension outside it can usually be ascertained with much greater accuracy by this means than by cystoscopy In the female quite small nodular growths on the posterior wall can be felt on vaginal examination

Urography—An excretion urogram will give a picture of the renal function and may reveal an associated papillary tumour of the renal pelvis Significant dilation of a ureter usually indicates infiltration around the intra mural portion of the ureter by growth A filling defect in the bladder X ray may show the position and size of the growth. When the outline of the bladder wall is still easily seen the probability is that the defect is due to a benign pedunculated papilloma. If however there is a bite deformity the tumour is infiltrating and undoubtedly malignant Examination for distant metastases is also necessary

Treatment of Tumours of the Bladder

There are several well established lines of treatment for neoplasms of the bladder These tumours must all be regarded as either malignant or potentially so and because no hard and fast division between the two is practicable exact indications for a particular operation or indeed a line of treatment cannot be given dogmatically Broadly there are two main forms of treatment

(a) when an attempt is made to eradicate or control the lesion and
(b) when this is not possible to palliate the effects of the disease

Methods used in an attempt to cure a bladder neoplasm are —

(1) Endoscopic resection and coagulation with diathermy
(2) Cystotomy with transvesical resection and coagulation with diathermy
(3) Partial or segmental cystectomy
(4) Total cystectomy (with ureteric transplantation.)
(5) Intracavitary irradiation.
(6) Interstitial irradiation by implant.
(7) External irradiation.

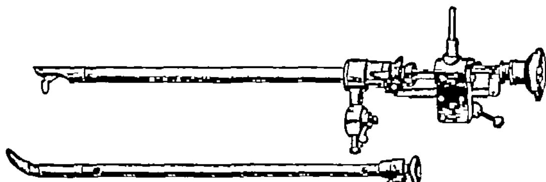


Fig. 1013.—McCarthy's resectoscope.

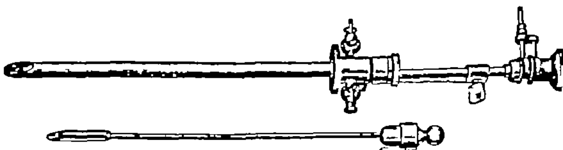


Fig 1014.—McCarthy s panendoscope.

Measures used for palliative purposes are —
(1) Uretero-colic anastomosis
(2) Uretero-ileal anastomosis and ileostomy
(3) External irradiation.

1 **Endoscopic diathermy** —This is the method of choice in the treatment of neoplasms of the bladder It should be used for all tumours which are still confined to the mucous and submucous layers which are accessible and not too large to be destroyed by one or two treatments Some urologists also resect tumours which have begun to infiltrate into the muscle wall Apart from coagulating small seedlings or for dealing with a small tumour on the anterior wall, the ordinary operating cystoscope with a flexible electrode is now rarely used. Two instruments both originally designed by McCarthy are

essential for the proper control of bladder growths —(i) the resectoscope (Fig 1013) and (ii) the panendoscope (Fig 1014) With the resectoscope papillary tumours can be completely removed down to and including part of the muscle layer

Method.—The patient is placed in the lithotomy position and the diathermy current is controlled at the level necessary for cutting A preliminary survey is made and this can best be done with a right angled telescope along the resectoscope sheath The tumour is charted on a cystoscopic chart The removal of growth is then commenced and when multiple in formation the small tumours are resected first

The loop is extended until it comes to lie behind a suitable sized portion of growth and with fluid running into the bladder the circuit is completed the loop wound forwards and the tissue resected under vision It is sometimes an advantage to cut away from the operator and this is safer if done with the bladder fairly full. All fragments removed are kept for histological examination Care must be taken not to cut into the bladder behind the growth until the pedicle is almost in view otherwise considerable bleeding may occur and the bleeding points will remain quite out of sight If the tumour is gradually resected however such bleeding as occurs can be dealt with quite easily Tumours of a size of up to 5 cms across can usually be dealt with quite expeditiously in one session by an experienced resectionist If situated very near the meatus in the male part of

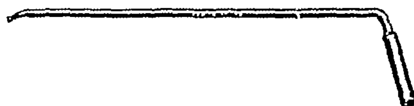


Fig 1015.—Ball electrode for panendoscope.

the prostate may also have to be resected It may be difficult or even impossible to reach a tumour on the anterior wall although some help is given if an assistant applies pressure on the abdomen immediately above the pubis.

When the tumour has been completely removed the muscle layers of the bladder with pale criss-cross fibres can be identified. Some tumours cannot be reached by the resectoscope and others may not be of such a size to warrant resection These may be coagulated and for this purpose the best instrument is the panendoscope. There are two sizes of operating sheaths—24 and 28 Charrière and through them quite large rigid ball electrodes (Fig 1015) can be manipulated By this means the treatment is far more expeditious and accurate than when a flexible electrode is employed. As a rule bleeding can be completely controlled but after a resection it is wise to leave a Foley

catheter in the bladder for 2–8 days post-operatively If the resection has been deep there is a risk that the bladder may perforate especially should there be any difficulty in micturition The abdomen should always be examined the following day to obviate such an event and if there is tenderness low down on the side of the operation, a careful watch must be kept. If at all doubtful a small incision should be made suprapubically A fresh extravasation will of course then be obvious and a corrugated rubber drain should be introduced alongside the bladder

2 **Transvesical or open diathermy**—This method is used for growths similar to those treated by endoscopic diathermy except that it is reserved for neoplasms confined to the mucosa which are too extensive or inaccessible by this route

Method.—The bladder is exposed through a transverse or vertical incision. The wound edges are carefully packed off with swabs soaked in saline. This is in an endeavour to prevent contamination of the wound with growth and throughout the operation constant care must be taken to avoid this. The bladder is opened by an incision planned if possible to avoid cutting into the growth. A self retaining bladder retractor is introduced and the tumour identified. At this stage the base of the tumour or tumours should be palpated to confirm that there is no infiltration into the muscle. The growth is then grasped in suitable holding forceps Those designed by one of us (A. W B Fig 1016) are particularly suitable as diathermy coagulation of the wound is prevented by the insulation Other patterns which may be used are Duval s and Fergusson s (Fig 1017) As far as possible the pedicle of the tumour is identified and using an angled diathermy needle or loop the whole tumour is resected off the bladder wall. Spurting blood vessels are frequently encountered and these are seized with pressure forceps and coagulated. When it is thought the main tumour has been removed, the bladder wall is carefully inspected for any small secondary growths which are destroyed either by resection or coagulation. A ball electrode similar in size to that used along the 28 Charrière sheath of the panendoscope is particularly useful for this and for coagulating bleeding points When the bladder appears clear of growth and bleeding a plastic urethral catheter is passed along the urethra fixed after the method of Harris and the opening in the bladder wall closed with two layers of plain catgut

The follow up of these cases is most important After a diathermy resection the patient should attend for cystoscopy in two months time preferably under an anaesthetic as it is essential to include an inspection of the posterior urethra. If there have been multiple papillary tumours it is not unusual to find one or two small flat seedlings in the bladder and these should all be coagulated. If the bladder has been cleared completely an examination should be done in six months in the first instance and then if clear on several occasions, at yearly intervals to afford a sure control

8 **Partial or segmental cystectomy** —The results of segmental cystectomy in properly selected cases can be good but will depend on an accurate pre-operative clinical assessment and equally precise operative technique

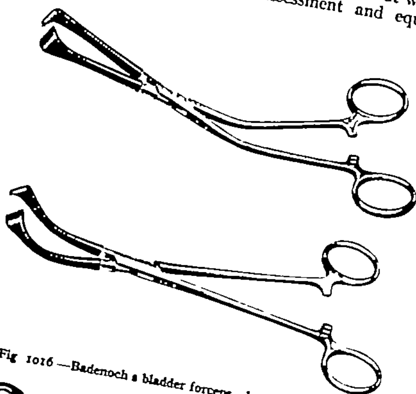


Fig 1016 —Badenoch s bladder forceps—long and short jaws

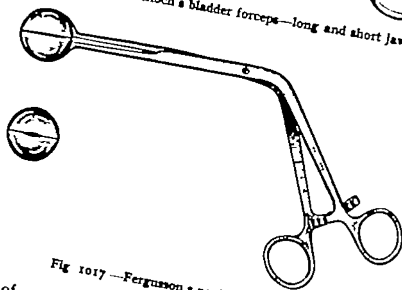


Fig 1017 —Fergusson s papilloma forceps.

The type of case best suited for a segmental excision is when there is a single lesion with a well defined margin and the rest of the bladder mucosa is quite normal At cystoscopy the proposed line of incision into the bladder must be planned and the possible width of clearance around the tumour estimated In an ideal case there should be a margin of at least an inch of healthy bladder mucosa and wall excised with the tumour A tumour at the vault or high on the lateral walls

is therefore suitable but when one encroaches on the trigone it may not be possible to excise it with a safe margin and yet leave adequate tissue for a functioning bladder The chances of adequate removal are small if the tumour has involved a ureter so that a re-implantation is necessary and the prognosis in consequence is then poor

Method —A catheter is passed and the bladder is emptied. A formal laparotomy with examination of the liver both kidneys and ureters para aortic nodes and nodes on the side wall of the pelvis is undertaken as a routine before examining the bladder The bladder with the tumour is then palpated to determine the degree of spread and the peritoneal surface is inspected. If it is puckered a wide area of peritoneum must be excised with the underlying portion of bladder The peritoneum is then dissected downwards and backwards to expose the seminal vesicles vasa and ureters on both sides Laterally it is raised off the pelvic wall and extraperitoneal fat together with any nodes palpable is dissected off the side wall of the pelvis and iliac arteries as far as the bifurcation of the common iliacs. It is only when the field has been defined by this exposure and the intestines packed off to prevent contamination that the bladder is opened. Remembering the position of the lesion and identifying it by palpation an incision is made through the bladder wall as far as possible from the tumour Once the lesion has been exposed the line of incision can be continued under direct vision taking special care to include as wide a margin as possible. If this results in little more than the trigone being left behind, it is sutured over a small suprapubic tube a urethral catheter also being left in When however a reasonable amount of wall is available the bladder can be reconstituted and drained by a urethral catheter alone

The two errors in partial cystectomy which more commonly lead to bad results are (i) employing the method in an unsuitable case without adequate assessment e.g when there are multiple tumours or other areas of abnormal mucosa. (ii) Inadequate excision, when the incision passes through submucosal growth spreading out from the tumour base

4 **Total cystectomy**.—This is a difficult and extensive operation which always entails some form of transplantation of the ureters. During the past twenty years its popularity has waxed and waned since the risks attached to it are considerable. However it still remains the most suitable procedure under certain circumstances and indications for its performance include the following —

i. When the lesion is too large for or not accessible to partial cystectomy or to a radio-active implant, and yet is still mobile
ii In multiple papillary tumours of low grade malignancy which cannot be controlled by diathermy resection and coagulation.
iii. When two infiltrating growths are present or when there are widespread changes in the bladder mucous membrane.

iv When a growth has been successfully controlled by irradiation but the patient continues to complain of marked frequency of micturition or there is recurring severe haemorrhage

v It may be considered as a palliative measure when severe symptoms persist after the ureters have already been transplanted even when eradication of the disease is not possible

Pre-operative preparation—The alimentary tract is prepared for transplantation of the ureters (*see* p 2298) the haemoglobin is estimated and the blood grouped and cross-matched since it is likely

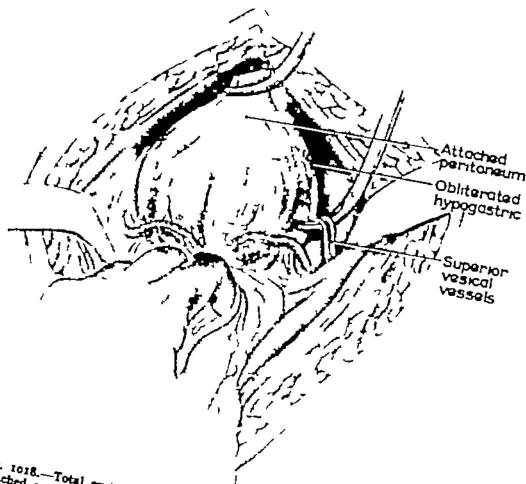


Fig. 1018.—Total cystectomy Superior surface of bladder showing area of attached peritoneum, obliterated hypogastric artery divided, superior vesical vessels exposed.

that some replacement will be necessary The patient is sent to the theatre with a rectal tube in position and immediately after anaesthetisation a catheter is passed and the bladder irrigated and emptied. An intravenous drip of a saline and dextrose solution is instituted.

Method—With the patient in the Trendelenburg position a mid line vertical sub-umbilical incision is made through the abdominal

wall and the peritoneal cavity is opened The liver kidneys para aortic and iliac glands are palpated to exclude metastases The bladder the pre-vesical space and lateral pelvic walls are palpated to estimate the degree of local spread. If surgical removal is practicable, *the mobile contents of the pelvis are displaced into the abdomen* and retained with packs Each ureter is exposed mobilised, divided, and either transplanted into the colon or temporarily packed off to be dealt with after removal of the bladder At this stage the anterior

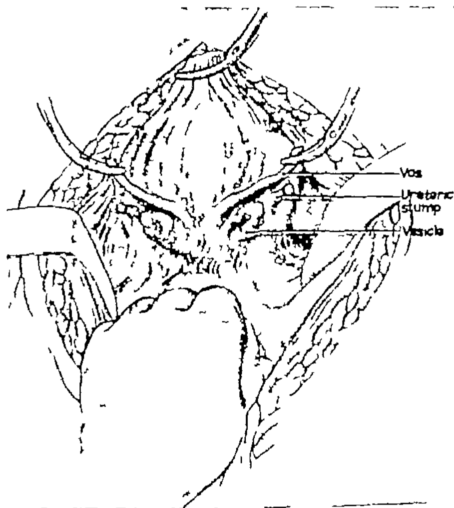


Fig 1019 —Total cystectomy Correct plane of cleavage behind divided vasa and seminal vesicles. Note stump of ureter

division of the internal iliac artery on each side is identified and ligated in continuity This greatly diminishes blood loss during the cystectomy The removal of the bladder is now commenced. In most cases only that part of the peritoneum which is attached to the apex of the bladder neck need be removed, but if the neoplasm is on the posterior wall of the bladder and especially if the spread has occurred through the bladder wall to pucker the peritoneum, a much

wider incision may have to be undertaken It is not the general practice to do a complete dissection of the lymph nodes from the common and internal iliac arteries Victor Marshall in New York has advocated that this should be done after a frozen section histological examination has been made of one of the nodes at the junction of the iliac arteries to exclude the presence of growth It is doubtful if this

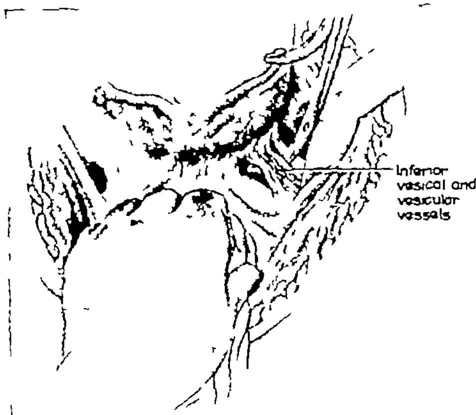


Fig. 1020.—Total cystectomy Inferior vesical and vesicular vessels exposed.

radical clearance is either anatomically practical or greatly influences the eventual outlook If small glands are palpable however one at least should be removed if possible as histology will undoubtedly help in forming an accurate prognosis and may suggest that post operative irradiation therapy should be given

The peritoneum is separated from the lateral aspect of the back wall of the bladder on each side In the male it is of importance that the vas on each side should be identified so that the plane between it and the peritoneum should be entered (Fig 1018) This will be a guide to the correct plane of cleavage and ultimately to the space of Proust between the prostatic capsule and the fascia of Denonvilliers lying over the rectum The superior vesical and obliterated hypogastric arteries are divided on each side (Fig 1019) and the paravesical fat and bladder are separated from the lateral pelvic wall down to the ureter the stump of which with ligature comes into view Deep to

this is the levator ani on each side with the inferior vesical and vesicular vessels still tethering the bladder (Fig 1020) These are picked up in Moynihan forceps and divided close to the pelvic wall. The bladder is now lifted up and together with the vasa and seminal vesicles is separated from the front of the rectum by blunt gauze dissection with a large swab (Fig 1021) The space of Proust between the prostate

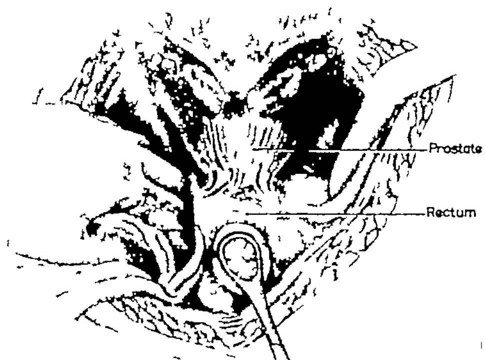


Fig 1021 —Total cystectomy Prostate separated from front of rectum by blunt dissection.

and Denonvillier s fascia is entered and the prostate is mobilised as far as the urethra The anterior aspect is now approached and on either side veins leaving the peri prostatic plexus of Santorini require to be picked up The pubo-prostatic ligaments having been divided, the urethra is identified (Fig 1022) divided between clamps and the whole block of tissue removed

In the female the operation may often be simplified by removing the uterus ovaries and tubes at the same time The incision in the peritoneum passes along the brim of the pelvis into the pouch of Douglas behind the cervix uteri The main pedicles are tied as in a Wertheim hysterectomy The vagina is opened in the posterior fornix and the incision continued anteriorly along the lateral aspect of the vagina thus avoiding the rectum In women the bladder is usually much thinner than in men and the risk of tearing through the wall is considerable.

There are usually some vessels still bleeding in the large fossa which is left after removing the bladder but these are mostly venous and are suitably dealt with either by diathermy or by under running with the boomerang needle If only a small area of peritoneum has been excised the pelvic floor should be reperitonised but if much has been lost no attempt should be made to do this since a pelvic floor denuded



Fig 1022 —Total cystectomy Bladder and prostate mobilised and urethra exposed.

of peritoneum is less likely to cause obstruction than is an inadequately repaired pelvic diaphragm After removal of the bladder the fossa must be drained for some days. In the female this can be effected by a tube in the vagina but in the male a corrugated drain should be brought out on each side suprapubically

5 **Irradiation therapy**—The insertion of radio-active material either occurring naturally or in the form of artificially produced isotopes is a method of treatment of bladder tumours which has been tried over many years and the indications for its use and the results following treatment are well defined.

The most suitable case for interstitial implantation is one where the lesion is single where the base is less than 5 cms across and when the tumour has not spread through the bladder wall The depth of infiltration is the effective limiting factor—where the tumour appears clinically to have spread through the bladder wall the probability of metastasis is so high that no form of local treatment is likely to be curative. The surrounding mucosa must be normal and there should be no suggestion of mucosal abnormality in the rest of the bladder

Such a lesion on the base of the bladder is unsuitable for partial or segmental excision and therefore implantation of a radio-active source is the method of choice.

The indiscriminate use of radio-active isotopes without accurate clinical and operative assessment of the lesion is dangerous may be useless and serves merely to bring any method into disrepute. In selected cases however it may be by far the best means of controlling a neoplasm of the bladder

There are several possible *methods of applying radio-active sources* and these can be divided into two main groups. The first is where the material implanted remains in situ as a permanent implant, and gradually loses its radio-activity according to its half life. In the second group the radio-active material is a removable implant and after a calculated amount of radiation has been given the source is removed.

The disadvantage of a permanent implant is that the amount of irradiation is determined by the technical quality of the implant of the radioactive sources and it is impossible to increase or decrease the amount of irradiation If the implant is technically poor tumour cells will remain and there will be a local recurrence of the growth.

A removable implant on the other hand permits correction of dosage either by shortening or lengthening the period for which the material is left in situ. Removable implants can be made with radium, tantalum or cobalt seeds in nylon tubes

Permanent implants can be made with radon seeds radio-active gold grains or by the injection of radio-active chromic phosphate. Radon seeds and gold grains have similar advantages in that they can be inserted into the bladder wall and a zone of tissue around each seed or grain will be subjected to irradiation Chromic phosphate injected as a solution may diffuse away from the point of injection and it is not possible to take radiographs of the distribution.

Method.—A catheter is passed and the bladder is emptied. If there is evidence of infiltration into the bladder wall a formal laparotomy is carried out with palpation of regional nodes and inspection of the liver

The extravesical space on the side of the lesion is then explored before the bladder is opened and the thickness of the tumour is assessed by palpation

(a) *Transvesical insertion of radon seeds or gold grains* —The bladder is opened through an incision which is clear of growth and a detailed inspection is made not merely of the obvious lesion but also of the remaining portion of the bladder wall before inserting a retractor If the bladder is inspected after the retractor has been inserted it is possible for a small tumour to be concealed behind the retractor blade. The tumour if pedunculated is grasped in suitable forceps (Fig 1016) and the pedicle cut with diathermy When the tumour is sessile a diathermy loop is used to shave off as much tumour as possible before

inserting the radioactive agent Whenever possible it is desirable to bring the mucosa into opposition to minimise the risk of chronic ulceration

Radon seeds or radio-active gold grains are both inserted according to Paterson Parker rules but in order to simplify the method of insertion various figures have been constructed to show the correct distribution for lesions of different sizes and also for different strengths of seeds The accurate placement dosage requires the co-operation of a trained physicist and radiotherapeutist

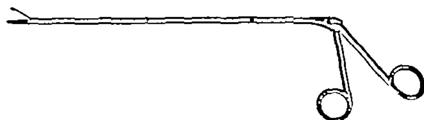


Fig 1023 —Alligator forceps.

(b) *Transvesical insertion of tantalum wire* —After exposure of the growth and inspection of the bladder a self retaining retractor is inserted and the growth grasped with suitable forceps (Fig 1016) The nearest part of the pedicle is divided and a traction stitch is inserted as a method of marking the end of the incision When the

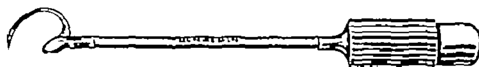


Fig 1024.—Boomerang needle holder

tumour is finally removed the catgut suture is used to close the mucosal defect. By applying traction to the two ends of the suture the incision in the bladder wall is raised as a ridge A boomerang holder (Fig 1024) fitted with twin needles is then passed through the bladder wall in the plane of the bladder muscle and in the line of this ridge in the direction of the internal meatus A loop of tantalum wire is threaded into the hollow ends of the needles which are then withdrawn so that the tantalum remains in the bladder muscle deep to the growth (Fig 1026) The two wires of the loop are placed one centimetre apart. A second or third loop of wire may be added to cover an area of 4–6 cms in diameter These wire loops are then tied to a catheter by means of about 6 inches of tough silk the catheter is fixed with a Harris stitch to the abdominal wall, and the bladder is closed

Depending on the linear activity of the wire the catheter is removed

after a period of 5–15 days The tough silk is grasped with pressure forceps and by steady traction the wires can be removed *per urethram* without necessarily re-opening the bladder

If the base of the tumour is still confined to the mucous membrane

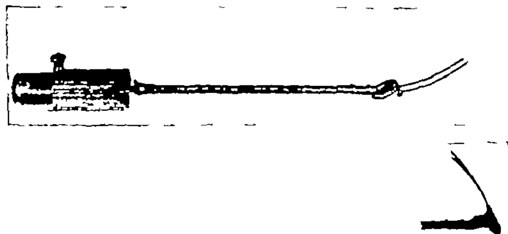


Fig 1025.—Wallace s twin needle boomerang introducer

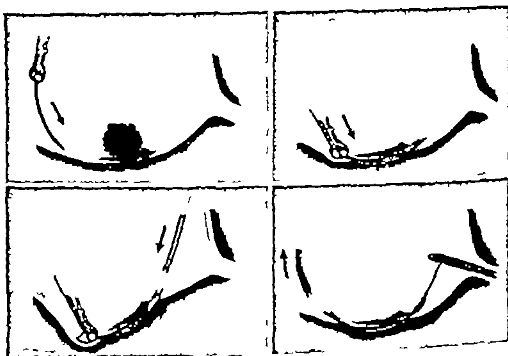


Fig 1026 —Technique of tantalum wire insertion.

diathermy excision alone is adequate If however there has been infiltration into the muscle implantation of the radio-active wire can effect complete tumour regression even without diathermy excision of the growth.

OPERATIONS FOR DIVERTICULUM OF THE BLADDER

Preliminary examination and treatment—The diagnosis of a diverticulum is made by cystoscopy and cystography On cystoscopy the number of diverticula and their position should be carefully noted because it is sometimes difficult to locate their orifices when the bladder has been opened Both ureters should be identified to ascertain the relationship of the ureteric orifices to that of the diverticulum and to ensure that neither opens into the sac. Cystoscopy also affords an opportunity of exploring the urethra for stricture and of ascertaining if there is any enlargement of the prostate It should be particularly noted that what may appear to be minor degrees of enlargement of this gland or the existence of Marion s disease at the vesical neck (p 2868) by obstructing the out flow of the bladder often lead to the formation of a diverticulum and operative treatment is incomplete unless this factor is also dealt with Posterior urethroscopy is necessary in some cases to decide this point.

A cystogram is often obtained as part of excretion urography but if the sac is not clearly seen a retrograde cystogram is necessary Anterior posterior half lateral and if possible lateral views are then taken these will show the shadow of the bladder and of the sac. The catheter which has been used to fill the bladder is then withdrawn and the patient passes as much urine as possible An X ray taken during the act shows the sac filling and one at the end will indicate the amount of residual urine

A full examination of the urine should be made since vesical infection is common Renal infection may also be present but is not usually sufficiently serious to contra indicate operative treatment. Renal function should be determined

If a diverticulum is large enough for any operation upon it to be necessary this should always take the form of diverticulectomy It is useless to attempt less than this and such a method as enlarging the orifice of the sac into the bladder is without benefit Diverticula have no power of contracture and when the patient micturates a portion of the urine flows out through the urethra and some often the greater quantity flows into the sac. Occasionally on account of the patient s feeble condition treatment may have to be limited to the removal of a stone from the bladder or from the sac but such limited procedures are not followed by permanent improvement and further calculus formation is to be expected and not infrequently the supra-pubic opening into the bladder fails to close The technique for removal varies with the size and position of the sac.

Technique.—A diverticulum may be removed through the bladder through the bladder neck after a retropubic prostatectomy or may be divided at its neck from the bladder and removed by dissection outside the bladder The exact method will depend on several factors If a moderate sized prostate has also to be removed the retropubic approach may be most convenient If the diverticulum is large and

especially if it is also infected an extravesical approach is safest and may be the only practical route A combination of routes may be necessary

Transvesical approach.—The bladder is exposed as for cystotomy (p 2820) through a 5-in. incision in the abdominal wall. A 3-in incision is then made in the bladder wall a self retaining retractor is introduced and the orifice of the diverticulum is located. A small uninfected diverticulum may sometimes be turned inside out by grasping its floor with tissue-forceps and then cutting it off at the level of its orifice If it is found to be adherent and cannot be thus inverted the lip of the opening is held with dissecting forceps and the mucosa incised immediately outside the margin for the whole of its circumference. The incision is deepened to include the muscular coat With the aid of dissecting or long pressure-forceps the orifice of the sac is lifted up into the bladder while the tissues immediately surrounding the neck are dissected with long curved scissors By this means the outer surface of the diverticulum begins to appear through the opening and the dissection is continued until the whole of it is drawn into the bladder A finger introduced into the diverticulum often facilitates this The dissection should be kept close to the wall of the diverticulum and if this is done the peritoneum, the vas, and the ureter are unlikely to be injured. If the urine is sterile and if the space left after the removal of the diverticulum is small and hæmorrhage therefrom slight the opening in the bladder wall from which the sac has been resected may be closed with interrupted sutures of No 1 catgut But if these conditions do not obtain it is sometimes better to leave a narrow piece of corrugated rubber extending from the depths out of which the diverticulum has been removed through the abdominal incision The bladder and abdominal wounds are closed as after cystotomy around a suitable tube. This method is particularly useful when more than one pouch especially if situated on opposite sides of the bladder have to be excised. The treatment of obstruction at the bladder outlet is discussed later

Combined approach.—This is especially suitable for a large diverticulum The bladder is distended with 8 oz of oxycyanide of mercury solution and the patient placed in the Trendelenburg position The bladder is exposed and is freed from the lateral wall of the pelvis on the side from which the diverticulum takes origin by dissection with the fingers the hand passing down towards the bottom of the pelvis and pushing the peritoneum upwards In this way the bladder with a considerable portion of the sac is cleared. When as much as possible has been effected in this manner the bladder is opened by a small incision through the vault and the fluid withdrawn by a sucker or if an indwelling catheter has been left in the bladder the bladder can be emptied per urethram without contaminating the wound. The incision is then prolonged down the lateral aspect of the bladder towards the orifice of the diverticulum A self retaining retractor

is then introduced to locate the opening more accurately A sucker is inserted into the cavity to empty the contents or the cavity may be swabbed dry The incision is prolonged to the orifice of the sac or the diverticulum may be cut off from the bladder at its neck from the outer aspect (The preservation of the ureter which is often closely related to the sac is discussed later) The incision is carried round the opening close to its margin and the neck of the sac is detached entirely from the bladder which falls towards the opposite side of the pelvis The edges of the diverticulum are picked up with tissue forceps and a dissection partly with scissors and partly with gauze, is continued until the whole sac is freed Adhesions are often very dense in the most inaccessible parts namely in the region of the ischial spine The process is facilitated if the dissection is kept close to the lining wall. Not infrequently the sac is accidentally opened at some point and rarely it may be necessary to leave a small portion of it behind in the bottom of the pelvis but no harm results from this Hæmorrhage is not usually severe and is controlled by the use of long pressure forceps The incision in the bladder wall is closed with interrupted sutures as in any other partial cystectomy care being taken not to compress the ureter

Extravesical approach—In this method the bladder on the affected side is cleared as in the previous paragraph It is essential in the extravesical approach to be able to empty or distend the bladder or diverticulum at will An indwelling catheter attached to an irrigator and an outflow facilitates the dissection of the neck of the diverticulum. The diverticulum is then freed detached from the bladder and the orifice is closed. This method is practicable if the diverticulum is a solitary one or if diverticula are confined to one side of the bladder and especially if the orifice is lateral and the sac rather far forwards The bladder neck may be examined through the orifice.

Difficulties and dangers. 1 *Adhesions.*—All sacs except the smallest are adherent to structures outside the bladder and if infection is present may be very stuck. For this reason invagination by tissue-forceps should be reserved for the smaller diverticula to avoid the risk of injuring the peritoneum or a viscus within it For very large diverticula it may in rare instances be necessary to open the peritoneal cavity

2. *Sepsis*—Severe bladder sepsis is no contra indication to operation and the results are usually very satisfactory if adequate bladder-drainage is provided after operation and suitable chemotherapy employed.

3 *Calculus.*—This is a frequent complication stones being found in the bladder in the diverticulum or in both They are removed at the diverticulectomy It may be necessary to enlarge the neck of the sac to extract the stone

4. *Neoplasms.*—A papilloma or infiltrating growth may be associated with a diverticulum being situated either at its orifice or inside the sac. A papilloma in the first situation is dealt with by diathermy through a cystoscope before operation or is coagulated at the time of the diverticulectomy. A growth within the sac is excised with it when possible.

5. Ureter involvement.—The ureter is in close relationship to any diverticulum which takes origin from the lower zone of the bladder. The commonest position for the opening of a diverticulum is slightly posterior to that of the ureteric orifice. From this the sac descends into the depths of the pelvis and as it does so its neck hangs over the ureter as the latter passes towards the back and upper part of the pelvic cavity. The ureter therefore lies between the neck of the diverticulum and the lower part of the bladder wall. It may be compressed here and dilated above this point. When such a relationship is anticipated before commencing resection of the sac, a stiff ureteric bougie or catheter or better a small flexible urethral bougie (say 8 Charrière) is passed under direct vision up the duct to the renal pelvis and the assistant takes care that this remains in position throughout the operation. Usually the ureter is exposed during the dissection but in some instances although the relationship is so close the ureter outside the bladder is not seen at any stage. Its position can always be determined by feeling for the bougie within it and if by chance it should be divided or injured the latter forms a guide to its position and an aid to its repair. In some cases the ureteric orifice is at the lip of the diverticulum and very careful dissection is then necessary. Rarely the ureter opens into the diverticulum; if so when the sac has been excised the ureter must be re-implanted into the bladder wall.

6. Vas involvement.—The vas is rarely seen if the dissection is kept close to the wall of the diverticulum. Occasionally it may be adherent, and sometimes it is necessary to divide it.

Treatment of associated obstruction to the bladder outflow.—Obstruction either at the vesical neck or below plays an important part in the development of a diverticulum and treatment is incomplete unless this factor is also dealt with. Conversely when once a diverticulum has formed complete cure is impossible by merely treating the obstruction for however complete this may be a diverticulum remains without power to empty itself owing to the absence of musculature in its wall.

(a) Stricture.—Urethral strictures should be dealt with at the time of operation or before diverticulectomy and subsequent treatment is equally important.

(b) Prostatic obstruction.—In some cases an obviously enlarged prostate is associated with a diverticulum and this may be removed retropubically as the first step in the operation. The sac may then

be removed extravesically assisted by a finger passed into the orifice through the bladder neck If on the other hand the patient s condition is such that he would not safely stand prostatectomy as well as the diverticulectomy the latter should be done first and the enlarged gland removed at a later date This order should never be reversed for if the prostate is first removed a succeeding diverticulectomy is more difficult on account of the scar tissue which has formed in the abdominal wall and along the fistula and persistent and severe bladder sepsis will almost certainly be present

When the obstruction is due to fibrosis of the vesical neck or to minor degrees of prostatic hypertrophy it can be very successfully dealt with by transurethral resection performed two to three weeks after

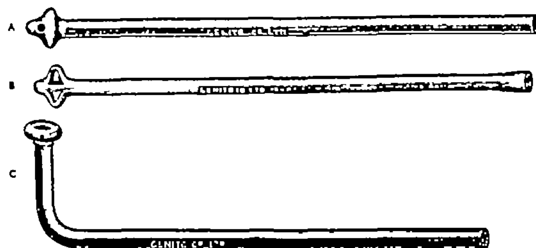


Fig 1027 —Self retaining tubes.
A. De Pezzer. B. Malécot. C. Winsbury White.

diverticulectomy It will be found that in many cases the suprapubic vesical fistula persists until this has been done although the degree of prostatic obstruction is apparently very slight *

Marion s disease, or stenosis of the vesical neck which is one of the causes of the formation of a diverticulum, can be dealt with by operation through the bladder at the conclusion of the diverticulectomy if the patient s condition is satisfactory In a few instances however it may be desirable to postpone treatment and in such cases this will usually take the form of perurethral resection which should be carried out before any attempt has been made to allow the suprapubic fistula to close

Post-operative drainage.—The bladder must always be drained after diverticulectomy If a prostatectomy has been performed and bleeding is adequately controlled an indwelling urethral catheter may be sufficient This should be left in for 8–10 days If bleeding has not been well controlled however it is safer to drain the bladder

Ogier Ward, Fifty-three Cases of Vesical Diverticula, *Brit. Journ. Surg* 1938, xxv No. 100, 790.
Bodenach, Congenital Obstruction at the Bladder Neck, *Ann. R. Coll. Surg. (Engl.)*, 1949 4 295.

with a small suprapubic tube such as a Winsbury White 26–28 Charrière. (Fig 1027) A corrugated drain should always be placed down to the site of the diverticulum and left in for 7 days.

OPERATIONS FOR FISTULA OF THE BLADDER

Vesico-vaginal fistula

Vesico-vaginal fistula may follow an injury at childbirth when it is often large or an operation on the pelvic organs in which case it is usually small rarely bigger than 1 cm. in diameter Occasionally it results from necrosis when radium has been used in the treatment of carcinoma of the cervix When this is the cause the condition is unsuitable for any local operation and is best treated by transplantation of the ureters

The fistula which follows a pelvic operation is usually situated at its vault but *may be in the middle line or more commonly in one of the* fornices It may be very minute a mere pin point or there may be a large aperture through which the interior of the bladder is visible. That following an obstetrical injury is lower down often encroaches on the trigone, and occasionally extends into the urethra. In such cases which are often seen in native women living under primitive conditions repair with continence is usually impossible—only ureteric trans*plantations can give relief. Often considerable induration surrounds* the opening and this adds to the difficulty of a repair operation through the vagina. In the majority of cases however operation by the vaginal route leads to cure (*see* p 2156) The transvesical methods described below are reserved for cases in which previous vaginal operations have failed to produce a cure or for those patients in whom the fistula is high up on the vault of the vagina, or is of unusually *large size*

Cystoscopy should always be carried out and the opening into the bladder if a small one can thereby be located. In case of larger openings a tight pack must first be placed in the vagina to allow distension of the bladder Cystoscopy may be necessary to distinguish a vesico-vaginal from a uretero-vaginal fistula occasionally both are present

Operative treatment has for its object the removal of scar tissue, the separation of the bladder from the vaginal wall, and the separate suture of each layer The patient is placed in the Trendelenburg *position and the bladder is opened through a* 4-in. suprapubic incision. Self retaining retractors are introduced and the region of the fistula is inspected and palpated An incision is made round this clear of all induration in the bladder wall usually at a distance of about ½ in from the fistula The incision is carried through the muscular wall of the bladder until the cellular tissue between it and the vaginal wall is exposed. The bladder wall is then undercut with curved

Mayo scissors to free it from the vagina to such an extent as to enable the fresh edges to be drawn together without tension A dissection of ½ to 1 in is usually sufficient but this depends on the size of the fistula and amount of induration present Hæmostasis is particularly important The vaginal orifice of the fistula together with the indurated tissue around it is excised with curved scissors There should be no risk of injuring the bladder wall if this has been suitably mobilized during the first part of the operation The resulting aperture in the vaginal wall is closed with interrupted sutures of chromic catgut of medium thickness The opening in the wall of the bladder is now closed by two layers of sutures of catgut Complete hæmostasis is essential since if a hæmatoma forms between the walls of the vagina and bladder the fistula will recur The bladder and abdominal walls are closed round a drainage tube of the Winsbury White type of about 28 Charrière (17 English) size. A light pack of gauze soaked in flavine 1 1000 is inserted in the vagina The after-treatment is as for a case of cystostomy At the end of ten days the bladder tube is removed and the suprapubic fistula usually closes spontaneously occasionally an in-dwelling catheter is required to hasten this

Very large fistulæ such as occasionally result from injuries at childbirth may require a more extensive operation. For these Swift Joly devised the following procedure

Transperitoneal operation.—A catheter is first passed to make sure that the bladder is completely empty A vertical median incision is made from the pubis to the umbilicus The peritoneal cavity is opened. The patient is placed in a moderate Trendelenburg position, and the intestines are packed off. The apex of the bladder is defined. The bladder is opened at this point and the incision through the bladder wall is carried backwards from this until the vault of the vagina is reached. The vagina is not opened. Two stay-sutures are inserted on each side of the bladder incision to serve as retractors By this means a very wide exposure of the fistula is obtained, and also it can be brought up almost to the surface.

The fistula will now be seen a short distance below the posterior end of the bladder incision The latter is continued down to the fistula, and then round it as a racquet but not through the vaginal wall. The bladder is separated from the vagina for at least 1 cm on either side of this terminal portion of the incision and for a similar distance round the fistula. The vaginal opening of the fistula is closed by a continuous catgut suture taking care to bring as much as possible of the raw surfaces of the vaginal wall into apposition This is done by passing the needle obliquely through the wall of the vagina (Fig 1028 (1)) The next step is to place from one to three mattress-sutures transversely from the angle between the bladder and vagina on one side to a corresponding point on the opposite side (Fig 1028 (2)) These sutures are put in to avoid leaving an open space between the

bladder and vagina this is an important step in the operation but one which may be very difficult The edges of the bladder incision now lie together, and have a tendency to become invaginated into the bladder They are united by a through and through continuous suture (Fig 1028 (8)) commencing at the posterior angle and continued

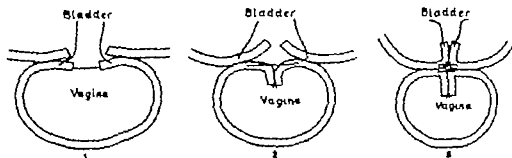


Fig 1028.—Swift Joly s operation for vesico-vaginal fistula. Application of sutures.

forwards until the apex of the bladder is reached where space is left for the insertion of a self retaining suprapubic tube of the de Pezzer type A continuous Lembert suture is passed through the peritoneum over the bladder incision taking care that no raw area is left where the bladder joins the vagina. This line of suture is continued up to the apex of the bladder and ends just behind the suprapubic tube, which lies entirely outside the peritoneum The peritoneal incision is closed without drainage.

After-treatment—The suprapubic tube is kept in place for a fortnight in order to give the bladder time to heal Care must be taken that it does not become blocked or kinked. At the end of a fortnight the tube is removed and a self retaining catheter is inserted through the urethra and left in position till the suprapubic sinus has closed. In this way the abdominal wound is kept dry during the whole of the convalescence

The success of the operation depends on the accurate suturing of the bladder wall The vaginal suture is not so important but is necessary to eliminate any weak spot which may subsequently give way and to provide support for the base of the bladder The mattress-sutures are inserted to prevent formation of a cavity between the bladder and vagina.

This operation is most suitable for cases of vesico-vaginal fistula following hysterectomy It can be performed when the fistula follows childbirth provided it does not involve the internal meatus. It is then much more difficult as the dissection of the bladder from the vagina is extensive, and has to be carried out at a greater depth. In these cases the uterus tends to get in the way A stay-suture should be passed through it and tied to the abdominal retractor This puts the vagina on the stretch and facilitates the dissection of the bladder from it

Entero-vesical Fistulæ

Fistulæ between the bladder and small intestine are rare and are usually the result of gunshot wounds swallowed foreign bodies or typhoid fever In treating them a temporary cystostomy and colostomy may be necessary and will be subsequently followed by laparotomy with the object of separating the intestine from the bladder and repairing both structures

Vesico-colic fistula.—Such a fistula is typically situated on the left side of the fundus of the bladder and is usually due to diverticulitis In 186 cases analysed by Lockart Mummery 12 had perforation into the bladder and developed vesico-colic fistula * Occasionally it results from a malignant growth of the bowel. Cancer of the bladder rarely gives rise to an intestinal fistula

The first step in treatment is the establishment of a colostomy proximal to the vesico-colic fistula. The pelvic colon may be used for this purpose if not affected by diverticulitis but in most cases an inguinal colostomy is not practicable and the transverse colon must be employed In a few weeks the affected segment of bowel should be resected and the continuity of the colon restored An exploratory laparotomy at the initial operation should be avoided on account of the massive induration in the pelvis unless it is necessary to determine which portion of the bowel is best suited for purposes of colostomy

OPERATIONS FOR INCONTINENCE OF URINE

Incontinence of urine may be due to (1) congenital abnormalities such as ectopia (*see* p 2828) epispadias which in the female may easily be overlooked or an accessory ureter opening into the vagina (2) impairment of sphincter control (3) destruction of the urethra in the female (4) *vesico-vaginal fistula* (*p 2864*) (5) *uretero-vaginal* fistula, (6) severe degrees of contracture of the bladder and (7) overflow from a distended bladder

Impairment of sphincter control must be discussed separately for the male and female.

Incontinence of urine due to sphincter impairment in the male. —Leakage of urine is normally prevented by both the internal and the external vesical sphincters and either is adequate to control micturition. In Wheelhouse's operation the external sphincter may be divided but the patient has control unless the function of the internal sphincter is also impaired as for example by the effects of a prostatic abscess or a previous prostatectomy The latter operation should therefore be avoided in a patient who has undergone external urethrotomy and *vice versa* It is however uncommon for prostatic enlargement to develop when there is a severe degree of urethral stricture of long standing

The function of the external sphincter is sometimes interfered with

* Late Results in Diverticulitis, *Lancet*, 1938, ii, 1401
J L. Ormond, J W Bast and M E. Klinger Vesico Intestinal Fistulae, *Surg Gynec. Obstet* 1940, 60, 411

after suprapubic prostatectomy This is usually temporary and clears up spontaneously in a few days or weeks Clearing a residual infection often helps in this The patient is instructed to exercise the perineal muscles This he learns by stopping the flow during micturition. Faradic stimulation may also occasionally help Before deciding on treatment the urethra should be explored with a cysto-urethroscope. If any contracture of the lumen is present it should be treated by dilatation up to full size and consequent absorption of scar tissue will often be followed by full control If such measures fail *Millin's modification of Lowsley's operation* for plication of the urethral bulb may be employed and has been followed by some success With the patient in the lithotomy position the region of the bulb is laid open with a midline incision after a catheter has been placed in the urethra The bulbo-cavernosus muscle is divided in the midline and the halves turned outwards thus exposing the corpus spongiosum of the bulb Four silk sutures are inserted to plicate about 1½ to 2 cm of this Each suture picks up the spongy tissue on one lateral aspect emerges and crosses the midline surface of the bulb and then takes a bite of the tissue on the opposite side The sutures are tied over the middle line just sufficiently tightly to grip the catheter The greater the degree of incontinence the smaller the catheter to be used sizes vary from 12 to 16 Charrière The catheter is removed after five to seven days No stricture will result provided that care is taken to ensure that the sutures do not penetrate the urethral mucosa.

Millin's antepubic sling repair may meet with more success than plication A strip of fascia lata 10 inches long is cut with a fasciotome. The abdominal wall is incised to expose the rectus sheath just above the symphysis pubis two vertical button hole incisions are made in the sheath and a long pair of pressure forceps passed between them to form a tunnel. At this stage the patient is placed in the lithotomy position a Tiemann catheter is passed along the urethra and a mid line incision made in the perineum to expose the posterior aspect of the bulb of the penis. The tendinous slip between the bulb and the central point of the perineum is carefully conserved since it will act as a saddle for the fascial strap The latter is then passed deep to the raphé posterior to the bulb so that when the ends of the strap are pulled, the bulb of the urethra is brought forwards on the urogenital diaphragm Two long pressure forceps are passed down from the abdominal wound in front of the symphysis pubis on either side of the root of the penis and the ends of the strap are seized and pulled up on to the abdominal wall The bladder is now filled with water the catheter removed and with the anaesthetist's co-operation the patient is made to strain Tension on the strap is so adjusted that no fluid escapes per urethram during straining The ends of the strap are passed through the rectus sheath tunnel sutured together and to the rectus sheath If difficulty in passing water is experienced in the post-operative period the tension on the strap can be loosened by flexing the knees on the abdominal wall.

Incontinence of urine due to sphincter impairment in the female.—This condition is most commonly due to childbirth and is due to weakness of the pelvic floor and is usually accompanied by cystocele It may occur without cystocele being due to weakness of the supports of the bladder neck and urethra. Very occasionally stress incontinence is seen in the adolescent virgin The condition is easily demonstrable since when the patient coughs a jet of urine is seen to escape from the external meatus

The treatment of incontinence in the female has always been a difficult problem and is usually dealt with in the first instance by the gynæcologist When it is accompanied by cystocele an anterior colporrhaphy is called for and in the large majority of cases the incontinence is either cured or greatly relieved When there is no cystocele or when failure has followed adequate vaginal and pelvic floor repair a different type of surgical intervention may be required and the most popular appears to be some form of sling

Aldridge* introduced an operation in which the approach is both abdominal and vaginal. A curved incision is made in the lower abdomen from the region of one anterior superior iliac spine to the other down to the rectus sheath and aponeurosis of the external oblique A flap of fascia 1 cm wide is raised starting over the rectus about 1 in. above the symphysis pubis passing upwards and outwards as far as possible The flap is left attached over the rectus and is cut free at its upper extremity A similar flap is raised on the other side. A Malecôt catheter is passed into the bladder with the patient in the lithotomy position an incision is made along the line of the urethra on the vaginal wall exposing the bladder neck. By dissection the anterior vaginal wall is raised off the urethra and lower part of the bladder and the paravesical space reached. A finger is passed inwards and upwards on each side to reach the prevesical space A long curved forceps is passed through this space and through the rectus to the position of the attachment of the fascial flap The free end of this is secured in the forceps and is pulled down. A similar manœuvre is carried out on the other side and these flaps are sutured together below the urethra and sling it up as in a hammock

Millin and Read† have designed a rather different sling operation It is all done from an abdominal approach The fascial flaps are cut from the whole length of the incision and remain attached near the region of the iliac spine. The prevesical space is opened into and the urethra found from above. Using a special curved forceps the slings are brought round the urethra and tied in front

Millin and Read have modified this and replaced it by a simpler operation in which it is claimed there is less risk of injury to the urethra than in the original procedure The operation is very similar to that described for treating incontinence in the male The rectus abdominis sheath is exposed above the symphysis pubis and two small button hole incisions are made on either side of the mid line. A strap of

* Aldridge, *Amer Journ Obst. Gyne* 1942, xliv 398
† Millin, Terence, "Retropubic Urinary Surgery" 1947 p. 184

fascia lata is prepared. The patient is then placed in the lithotomy position the labia sewn back, a catheter passed and a short incision made between the clitoris and the anterior aspect of the external urinary meatus.

The urethra is then lying in the depth of the wound and can be dissected free from the anterior wall of the vagina. The dissection can be carried up albeit in a somewhat restricted space till junction of the urethra and bladder is reached. The strap of fascia lata is passed behind the urethra and the free ends seized in forceps. The latter are forced up behind the symphysis through the rectus abdominis muscle and present through the button hole incisions.

The bladder is filled and with the anaesthetist's co-operation, the patient is made to strain. The free ends of the strap are tightened until no urine escapes during straining. The strap is then anchored to itself and to the rectus sheath.

An alternative operation to that employing a sling has given at least as good results. It is a form of cystopexy (Everard Williams Marshall Marchetti Kranz.) A Malecôt catheter 24 Charrière size is passed into the bladder the neck of the bladder is exposed retropubically and easily identified by the indwelling catheter. The first part of the urethra, the neck and anterior wall of the bladder are dissected free and sutured to the back of the symphysis pubis with a series of 4–6 chromic catgut sutures so that the whole bladder neck and lower segment are firmly supported and adhere to the back of the pubis.

CHAPTER XLII

OPERATIONS ON THE PROSTATE

By R OGIER WARD and A W BADENOCH

Anatomical and physiological considerations.—The prostate is a multi lobed gland which lies between the neck of the bladder and the triangular or urogenital ligament and encircles the first part of the urethra. The gland is quite small in the young adult and probably weighs between 5 and 10 gms In a considerable proportion of men over the age of 50 years the gland enlarges This enlargement is variable and glands of over 700 gms. have been removed The increase in size distorts and compresses the internal meatus and urethra and causes a disturbance of micturition The enlargement may be chiefly subvesical but commonly there is also an intravesical projection As the latter develops it stretches the internal sphincter and distorts the mucous membrane around the internal urinary meatus When the enlargement involves the lateral lobes the anterior commissure is transformed into a cleft or V Enlargement of the middle lobe or of a lateral lobe at the posterior commissure causes a rounded intravesical projection at this aspect. The enlargement is nodular and usually a few larger nodules form although there may be numerous small ones These nodules compress any remaining normal prostatic tissue and form a false capsule It is for this reason that the nodular enlargement can usually be enucleated easily from the remainder of the gland The enlarged part of the gland is situated above the openings of the ejaculatory ducts These pass through the prostate to open on either side of the verumontanum. At the enucleation the urethra is usually divided about this level just below the verumontanum. After the enucleation the cavity contracts to a considerable extent as also does the opening from it into the bladder A flap of trigone may be left posteriorly with the seminal vesicles lying behind and external to it. The vesicles are not usually exposed at the enucleation but if the nodular part is adherent behind and if the false capsule is not well marked they may remain attached and require to be divided with scissors

The main arterial supply to the prostate comes from the inferior vesical artery on each side There is a variable number of vessels The arteries pass through the capsule on each side in its postero-lateral aspect and divide early into several branches After enucleation one or more of these vessels may be seen spurting in the postero-lateral aspect of the fossa. There is occasionally an accessory supply from the obturator or long pudendal arteries Surrounding the prostate enclosed in the true sheath is a plexus of veins—the plexus of Santorini If this is inadvertently entered much bleeding occurs

In addition to benign enlargement the prostate may be the site of infection of stone formation or of malignancy each of which may require surgical intervention. After prostatectomy the internal sphincter does not regain its function and the compressor urethræ or external sphincter controls the overflow of urine. The prostatic cavity gradually shrinks down and becomes epithelialized.

Sexual function.—The patient is almost invariably sterile after partial or total prostatectomy and of course there is no doubt at all about this if both vasa are divided As a result of the operation the internal sphincter is not competent and during the sexual orgasm semen passes directly from the prostatic urethra into the bladder On the other hand potency is not affected although impotence is said to occur occasionally after perineal prostatectomy

Choice of Operation

Until the end of the last century no satisfactory approach had been found to deal with prostatic obstruction Guthrie (1830) and Mercier (1841) had attempted to divide the bladder neck but it was not until the revival of suprapubic lithotomy was shown to be comparatively safe that any real attempt was made to remove the obstructing lesion Bellfield (1886) in America and McGill (1887) in Leeds deliberately removed the intravesical projection of the prostate and they and others may have enucleated the whole of the nodular enlargement Much has been written and great ill feeling and resentment was generated in the early part of this century on the question of priority of the introduction of this operation In 1901 Freyer certainly did this, and apparently accidentally He then did a deliberate enucleation of the whole of the enlargement finding that not only did many of the patients recover but could also pass water Freyer was not the first to enucleate the whole of the nodular enlargement He may have been the first to do it deliberately and undoubtedly he publicised the method He put it on a reasonably satisfactory surgical basis and enucleation of the nodular enlargement transvesically is known in this country as Freyer s prostatectomy

Various modifications of transvesical prostatectomy have been introduced most notably those by Harris (1929) of Sydney and Wilson Hey (1945) The perineal approach to the prostate has been popular in the countries of Europe and America and indeed in many clinics overseas and is still extensively used. It has never been widely accepted in Great Britain and is rarely if ever performed. It requires more skill and training than transvesical prostatectomy and is an unsuitable operation for a general surgeon. The mortality is not less than that obtained in specialized clinics where retropubic and transvesical prostatectomy are performed and even in the most skilful hands there is a greater risk of incontinence and impotence than with other methods and it is not proposed to describe the operation

In 1945 Millin introduced a new approach to the prostate through the retropubic space His method and approach have now been

extensively employed and in many if not most clinics in this country and also throughout the world it is now accepted as the method of choice With this approach more easily than with any other the whole of the prostatic fossa can be seen all obstructing tissue accurately removed and bleeding adequately controlled The bladder wall is not opened and there is less risk of leakage than with the transvesical operation Bladder spasms occur much less often than when supra pubic drainage of the bladder is employed. It is especially suitable for big enlargement of the prostate

Endoscopic prostatectomy in its modern form was first evolved by Young in America and his cold punch has been developed by Brasch and Thompson We owe to McCarthy the resectoscope employing a loop with a diathermy current and endoscopic resection of the prostate has been largely developed in America There are two types of instruments—the resectoscope which employs a loop which cuts with diathermy and the cold punch which acts by means of a tubular knife. There are some urologists who still consider that all prostates should be removed transurethrally but especially in this country the majority of surgeons employ an open operation in most cases On the other hand endoscopic surgery has become a universally established procedure amongst urologists for dealing with a proportion of cases of bladder neck obstruction

With these various types of operation at our disposal there must be some selection in their employment In our view when the prostate can be easily felt bimanually to be enlarged the case should be treated by enucleation When little or no enlargement can be felt and yet there is obstruction at the bladder neck then it should be treated endoscopically

Operations of election should be performed when practicable in properly equipped urological centres and then an operation with closure should be employed We favour the retropubic approach Many diverticula of the bladder can be dealt with extravesically and stones of moderate size certainly up to 8 cm. in diameter can be removed through the bladder neck When however it is necessary to open the bladder for some complication it is reasonable to enucleate the nodular enlargement and deal with the case after the manner of Harris or Wilson Hey A small percentage of patients are not fit for prostatectomy either for general constitutional reasons or on account of renal insufficiency and require preliminary drainage If this is done through a suprapubic tube it may influence the type of prostatectomy If the fistula is low and the patient fat a Freyer type operation is quickest and on the whole safe. If on the other hand the drain has been brought out 8 inches above the symphysis and especially if the patient is thin, and the gland very large a retropubic prostatectomy may well be easier and safer than transvesical enucleation and should be done. If it is necessary for a patient to receive treatment in a situation where prostatectomy is very occasionally performed a two-stage suprapubic Freyer prostatectomy is the safest and least

worrying procedure. In our practice 80 per cent. of cases are treated retropubically, 17 per cent. are treated endoscopically and 3 per cent are done through a transvesical approach.

Preliminary investigation.—The large majority of patients with obstruction at the bladder neck are fit for operation without preliminary drainage. Until recently chronic retention was usually treated in two stages but more and more urologists influenced by the work of Wilson Hey and Wells consider this to be rarely necessary If the patient looks well has a clean tongue good appetite and is excreting concentrated urine it is probable that the kidney function is adequate. If on the other hand the tongue is furred if he is listless constipated and the urine is pale and diluted the bladder will almost certainly require preliminary drainage The following investigations should always be done before prostatectomy (1) routine examination of the urine together with culture (2) estimation of the blood urea, (3) blood group (4) hæmoglobin level and (5) intravenous pyelogram. Estimation of the blood urea is important If below 50 mgm per 100 ccs. renal function will be adequate. If it is over 80 mgm. per 100 ccs kidney concentration is likely to be poor and a one-stage operation is a more doubtful risk. Between these two readings the assessment of risk will be based on general consideration or on the result of an intravenous pyelogram. If the blood urea is over 80 mgm it is unlikely that dye will be sufficiently concentrated by the kidneys to show a shadow on X ray and with this reading the bladder should be drained for a minimum period of 14 days. Below this reading a urogram should be done Much can be learned from it It may reveal an unexpected opaque calculus. The rate and degree of kidney concentration will be shown as will the presence of back pressure in the upper urinary tract The bladder shadow is seen and will show trabeculation perhaps sacculation or a diverticulum a filling defect from upward projection of the prostate and in an after micturition film the amount of residual urine.

With the history physical examination and these investigations we are usually able to decide whether or not operation should be advised and whether it should be done in one or two stages It may not be possible however to decide on the exact method until after cystoscopy This examination should always be done before a prostatectomy but it is our practice to do so with the patient already in the theatre anæsthetized and prepared for operation. This investigation is especially necessary if the bladder is not to be opened since otherwise stones especially of uric acid, a diverticulum or a small neoplasm may all be overlooked. It is unwise to cystoscope a patient with bladder neck obstruction except immediately prior to operation If the gland is very big, the instrumentation may be followed by bleeding The patient may be precipitated into complete retention or an infection may be caused or exacerbated.

Pre-operative preparation.—The patient is admitted to hospital bathed and the abdominal scrotal and perineal regions are shaved.

A mild aperient is given the night before but purging is avoided. It is wise also to administer a sedative and so ensure a reasonable night's rest

RETROPUBIC PROSTATECTOMY OR MILLIN'S OPERATION

This operation was introduced by Millin in 1945 and has proved a most successful procedure now widely performed as the operation of choice for prostatic enlargement

Special instruments required are a boomerang needle (Fig 1024, p 2347) catgut holder (Fig 1029) and self retaining retractor with posterior blade (Fig 1030)

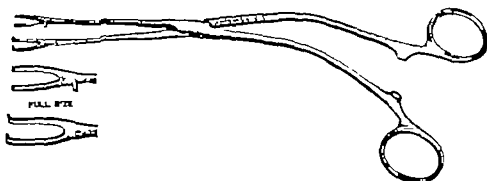


Fig 1029 —Harris ligature carrier

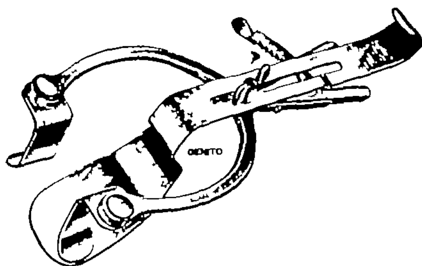


Fig 1030 —Millin's retractor

Technique.—A cystoscopy having been performed and the bladder left empty the patient is placed on the operating table in the supine position and the skin of the whole operation area which includes the penis and scrotum prepared with a suitable antiseptic The towels are arranged and the table tilted to about 30° of Trendelenburg position A curved incision four inches long is made in a skin crease one inch above the symphysis pubis and this is deepened to expose the external

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Retropubic Prostatectomy or Millin's Operation

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Special instruments required are a boomerang needle (Fig 1024 p 2847) catgut holder (Fig 1029) and self retaining retractor with posterior blade (Fig 1030)

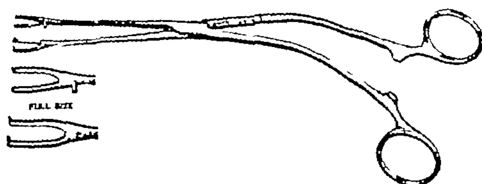


Fig 1029.—Harris ligature carrier

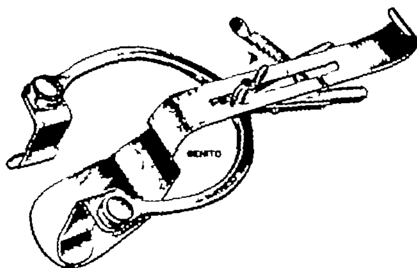


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oblique aponeurosis over the recti muscles All bleeding points having been controlled the aponeurosis is divided in the same line as the skin incision and dissected off the pyramidales and recti muscles. The latter are separated from each other in the mid-line and the bladder and prostate exposed in the retropubic space of Retzius A self retaining retractor is inserted Millin s pattern (Fig 1030) being especially suitable The lateral blades retract the recti and the middle blade holds the bladder and peritoneum away from the prostate.

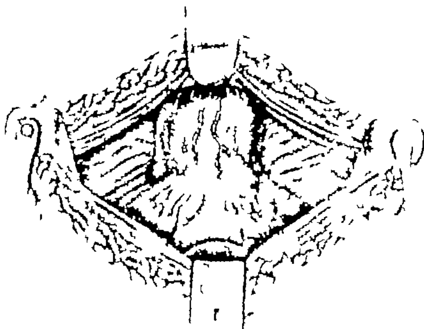


Fig 1031 —Retropubic prostatectomy The prostate exposed.

A small gauze pack is placed on either side of the prostate (Fig 1031) This helps to show up the gland but care must be taken in placing the packs in order to avoid tearing one of the numerous pelvic veins The terminal branches of the dorsal vein of the penis are seen coursing upwards through the preprostatic fat to join the plexus of Santorini. They must be dealt with and a simple method is to under run the vessels with the boomerang needle and divide them between two ligatures (Fig 1032) The anterior surface of the prostatic capsule is now cleaned and a transverse incision is made down to the adenoma or nodular enlargement (Fig 1032) The latter can usually be distinguished by its rather pale colour The length of the incision in the capsule will vary with the size of the gland but will be a minimum of 3 cms During this time the field is kept clear by a sucker which is an essential tool. Any spurting vessels and there is often one on each side of the capsule are now picked up and dealt with Using a pair of long curved scissors of the Thomson Walker type the line of cleavage is entered and the nodular enlargement is freed from the

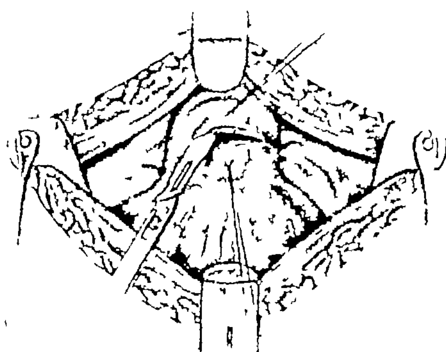


Fig 1032.—Retropubic prostatectomy The preprostatic vessels have been under run and the capsule is incised.

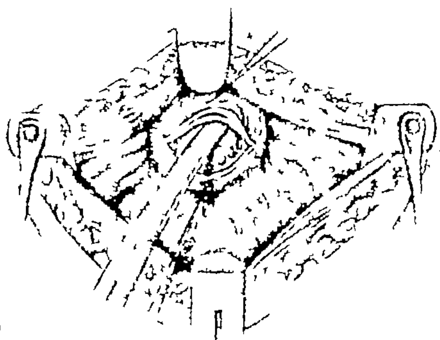


Fig 1033.—Retropubic prostatectomy The capsule is freed from the enlarged part with scissors and the urethra is divided.

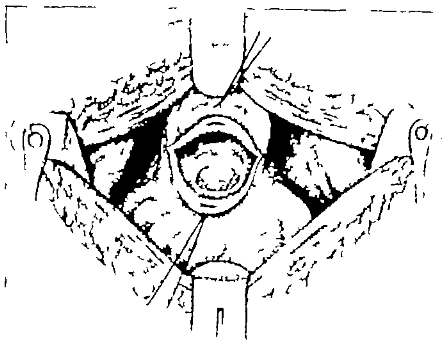


Fig 1034.—Retropubic prostatectomy The enlargement has been enucleated. The dotted triangle on the posterior commissure marks the area of bladder neck which is excised.

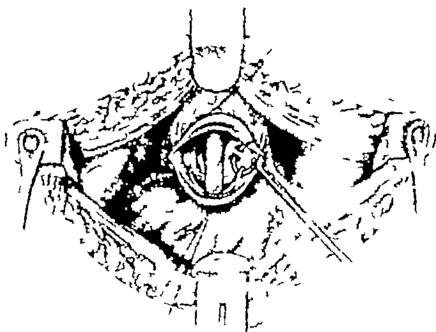


Fig 1035.—Retropubic prostatectomy The catheter has been introduced. A lateral stitch picks up the edge of the bladder neck and joins it to the side of the capsule.

false capsule in front as far as the urethra (Fig 1033) A finger may help at this stage The urethra is then divided with scissors and we think this is important as the membranous part is then less likely to be pulled up and torn The retractor can now be temporarily removed Whilst the enucleation is continued digitally care must be taken in so doing not to tear the capsule laterally since bleeding will then always occur and may be difficult to control The gland is left attached to the neck of the bladder the retractor is replaced and the removal



Fig 1036 —Whistle tipped catheter

completed under direct vision Using the prostate itself as a retractor the bladder neck is dissected off in front the bladder opened and the trigonal flap exposed. A wedge is removed from this flap and the whole enucleated gland is now freed and can be lifted out of the wound

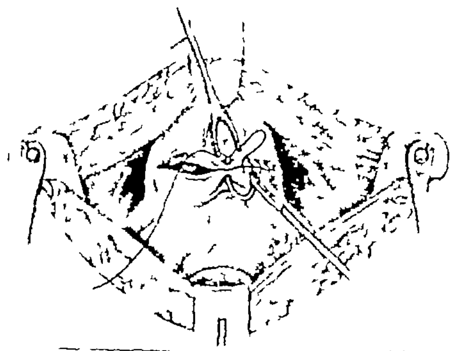


Fig. 1037 —Retropubic prostatectomy The capsule is closed with a continuous suture

The fossa is inspected bleeding points controlled and any tags or residual attached nodules removed We usually control the bleeding by under running the vessels with catgut on a boomerang needle Some urologists coagulate these with diathermy

A catheter is now passed into the bladder along the urethra. We prefer either a Harris or a whistle-tip (Fig 1036) catheter made of

plastic The size should be less than the external urinary meatus, usually 20 or 22 Charrière. The catheter is fixed by a long nylon suture which passes through the tip with both ends of the suture brought through the bladder and abdominal walls to be fixed on a small metal bar (Fig 1038) The edge of the bladder neck is now sutured to the lateral wall of the prostatic fossa on either side The purpose of these stitches is mainly hæmostatic. Actual spurting vessels are only seen in about 25 per cent of cases and these sutures are introduced in the region where the bleeding most often occurs. These lateral stitches also help to obliterate the prostatic fossa. When satisfied that the bleeding within the cavity and at the cut bladder neck is controlled the transverse incision is closed with a continuous

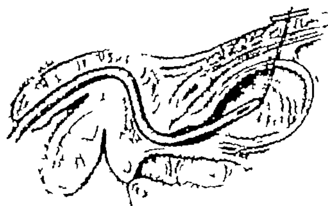


Fig 1038 —Retropubic prostatectomy Method of fixing the catheter (after Harris)

stitch This should be placed so that a good bite is taken on each side, and the whole thickness of the capsule is included (Fig 1037) The wound is then closed in layers and a corrugated drain left down to the capsule incision

Vasectomy —The vasa are exposed divided and ligated. This should be a routine procedure in every open prostatectomy and may be done with advantage in endoscopic operations also

Technique —The vas is identified and fixed between the finger and thumb of the left hand. An incision 1 cm long is made along the line of the vas it is seized with toothed forceps picked up divided and ligated.

The bladder is now irrigated the catheter adjusted so that it is draining well and fixed. It is helpful to inject 100 ccs. of 1 1 000 watery solution of flavine into the bladder and to spigot the catheter This fluid is allowed to remain in for one hour after which free drainage is instituted.

The average blood loss with this operation is 250 mls (10 oz.) If this is not exceeded a blood transfusion is unnecessary

Post-operative care and progress.—The spigot is removed from the catheter and the yellow flavine solution drains out If this does not occur immediately on removal of the spigot it is probable that a clot is blocking the catheter and this is sucked out with a syringe The catheter is connected to a six foot length of rubber tubing with a wide bore glass connection It is most important in this as in any other form of closed prostatectomy that drainage along the catheter should be continuous Constant attention is necessary especially during the first two days when small clots are likely to form and block the drain If these are removed as soon as drainage ceases recovery is uneventful. It is quite usual for suction to be necessary several times during each of the first two days The bladder should not be irrigated other than at these times and then a maximum of 60 ccs (2 oz.) should be introduced at a time. Commonly there is considerable drainage into the dressings through the suprapubic drain in the first few hours and the top dressings should be removed and replaced. As soon as the patient is conscious he is propped up encouraged to drink and exhorted to move his limbs and to do deep breathing exercises A sedative and opiate are given on the first night Dressings are renewed next day and he is allowed to sit out of bed The suprapubic drain is taken out on the fourth day by which time he is usually quite ambulant As a rule the urine clears quickly and by the fourth or fifth day bleeding has ceased. The catheter can then be removed. Should there still be some bleeding however it is often wise to leave the catheter in a few days longer When the catheter is removed the patient usually passes water easily but in about half the cases control is not very good and at first urine is apt to leak. In an uncomplicated case however control quickly returns and by the end of fourteen days he is passing water well with a good stream and good control.

Freyer s Operation—Transvesical Prostatectomy

A catheter is passed and the bladder distended with 8 oz sterile water The surgeon stands on the patient s left and the assistant on the opposite side An incision is made in the abdominal wall and then into the bladder * of just sufficient length to allow two fingers of the right hand to enter—usually about two and a half inches The left hand wearing two gloves and with a sterile towel wrapped round the fore arm is passed beneath the towels arranged on the thighs and the first two fingers are introduced into the rectum These are used to push the prostate up towards the surface and to steady it during enucleation In cases in which the enucleation is easy it may be sufficient merely to support the perineum by pressure with the fingers of the left hand through the towels Meanwhile with one of the fingers of the right hand the enucleation is commenced

The enucleation.—Freyer began this by tearing through the mucosa overlying the intravesical projection near the mid line posteriorly

* As for cystotomy see p. 2321.

and thus entering the plane of cleavage between the adenomatous enlargement and the pathological prostatic capsule Another method and one more generally employed is to pass one finger down into the cleft of the urethra and then pressing outwards and slightly forwards to break through the mucosa immediately in front of the anterior margin of the upper part of the lateral lobe and thus lay open the plane of cleavage This process may be begun either on the right or on the left side The finger perhaps aided by the adjoining one is now carried round in this plane through a complete circle until the plane is laid open around the entire circumference of the intravesical projection and internal urinary meatus The enucleation is then continued deeper on the anterior aspect and thus the finger passes through the internal sphincter into the subvesical region.

There are three points of attachment of the enlarged prostate to its surroundings posteriorly at the level of the verumontanum where the band of tissues containing the ejaculatory ducts join the urethra anteriorly where the anterior commissure is adherent along the middle line and at the apex where the prostatic urethra joins the membranous portion. The last two of these attachments are freed by passing the finger deeply in front of the enlargement and on either side of the middle line until the urethra is reached and is torn across The ejaculatory ducts hold the urethra so that its posterior wall is usually torn across just above the verumontanum. The tear is very oblique and not until the lobes are detached is this posterior part of the urethra severed. The enucleation is continued by thrusting the finger down behind the enlargement between it and the tissues covering the seminal vesicles This process is continued more deeply and around the gland until the prostate is freed from all attachments. It is then manipulated into the bladder-cavity which is not always easy if the enlargement is chiefly subvesical and if the internal sphincter has not been stretched by considerable intravesical projection. Against the rectal fingers the walls of the prostatic cavity are now carefully palpated to ensure that no portion of the main mass of the prostate nor any separate adenoma has been left behind

A modification of this method of enucleation was described by Bentley Squier and was also advocated by the late Harry Harris in his writings on prostatectomy The forefinger is introduced deeply into the prostatic urethra and the mucous membrane ruptured where it covers the lowest part of one or other lateral lobe, about the level of the verumontanum and anterior to it. Each lateral lobe is then enucleated from below upwards If this method is employed injury to the membranous urethra is very unlikely

The fingers having been withdrawn from the rectum a nurse removes the coverings of the left forearm and strips off the outer glove without contaminating the one worn beneath it The prostate is drawn out of the bladder usually with the fingers but occasionally some extra aid such as lithotomy forceps is necessary The bladder is washed out with lotion or water at 120° F to arrest hæmorrhage Freyer con

sidered this important but most surgeons omit it A large tube with a thick wall with a bore of ¾ in and two lateral eyes cut in it near the lower end is introduced so that at least 2 in of it are in the bladder cavity Marion s tube is most suitable (Fig 1039) The end of the tube must not however be allowed to extend down to and press upon the trigone One or perhaps two sutures may be necessary to bring the recti together and the wound is closed with silkworm gut sutures one of which transfixes the tube

Freyer's operation in two stages.—If an interval of only one or two weeks has passed since the cystostomy was performed the wound is easily re-opened throughout its length If necessary it can be extended When however the original incision has healed with the exception of the fistula—and this will usually be the case—fresh dissection is necessary

If the tube inserted at the preliminary cystostomy was brought out of the abdominal wall 2 in. or more above the symphysis pubis and if the patient is not fat and scar tissue is not abundant it is possible after the tube has been withdrawn to enlarge the incision sufficiently by passing a scalpel down the sinus and cutting through all the tissues of its wall towards the symphysis pubis Two fingers of the left hand are then introduced into the rectum and a finger is passed through the sinus to the prostate which is enucleated. In many cases however this is unfortunately not easy the original cystotomy may have been made too low or scar tissue may have developed and made this part of the abdominal wall unyielding Attempts to enucleate the prostate under such conditions through too small an incision may lead to tearing the peritoneum It is therefore better to *excise the scar* To do so the line of this in the skin should be extended towards the umbilicus for an inch or more and deepened for above the scar the layers of the abdominal wall can be differentiated. The rectus sheath is opened and the muscles are identified and separated and lifted up from the extra peritoneal tissues Partly by blunt dissection and partly by cutting with scissors or a knife the wound is opened in the middle line down to the fistula. It will often be necessary to resect some of the scar tissue Dissection is carried round the fistula on both sides down to the symphysis pubis and the track is thus detached from the remainder of the abdominal wall. During this process careful attention must be paid to the position of the peritoneum as this is often closely adherent both above and lateral to the point where the fistula enters the bladder Injuries to the peritoneum are avoided by deliberate dissection full retraction of the abdominal wall and transverse cuts with the points of curved scissors or a knife while the assistant pushes the peritoneum gently upwards When the fistula is freed it is cut away from the bladder wall beginning on the aspect nearest to the symphysis pubis and working upwards to the neighbourhood where the peritoneum may be still attached. When this has been done the opening is dilated and a finger introduced into the bladder now hooks

the viscus up out of the wound. The freeing of the peritoneal reflexion is continued by cutting transversely until sufficient of the bladder wall is exposed to permit adequate incision through it vertically If the peritoneum is accidentally opened the region should be protected by gauze and the dissection continued until the bladder is sufficiently free The peritoneum is then closed with a continuous suture of No 1 catgut and allowed to fall back It is always wise to examine the peritoneum after the enucleation since it may be torn during this procedure.

The prostate is then enucleated and the remainder of the operation completed In closing the abdominal wall it may be necessary to define by dissection the various layers which are involved in scar

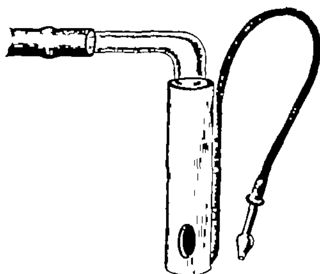


Fig 1039 —Marion s bladder-drainage tube.

tissue and perhaps to under-cut the skin but as a general rule the less dissection the better as it lays open fresh areas in which infection may develop The layers should be sewn up carefully and separately and a firm bandage applied Stitches in these cases are likely to cut out and the skin-edges to separate for this reason a suprapubic box is best avoided.

After-treatment. Local.—The bladder is irrigated twice daily for the first ten days with Milton solution 1 drachm to a pint or oxycyanide of mercury 1 6 000 by means of a rubber catheter introduced through the tube If Marion s tube (Fig 1038) is used this can be done through the side inlet About the fourth day the large tube is replaced by a smaller one in which two lateral eyes should also be cut A convenient way of introducing it is to select a piece of tubing of a size suitable to pass through the larger one which is drawn out over it. It is then cut short and transfixed by a large safety pin to prevent

it from slipping into the bladder The length of this tube like that of the tube used at operation will vary with the thickness of the abdominal wall but is such that 2 in are within the bladder As soon as hæmorrhage has ceased or become minimal this tube may be replaced by a Malecôt or a variety of de Pezzer tube On the tenth day the tube is removed and the wound allowed to close Until then the bladder is washed out through the fistula once daily During this period of convalescence a Hamilton Irving or better, a McDonald box is usually employed to collect the urine

It is advisable about the tenth day to pass an instrument through the urethra into the bladder Sometimes the torn upper end of the urethra becomes closed by adhesions but at this stage a urethral instrument easily re-opens the way Many surgeons prefer to pass and tie in a catheter A Tiemann No 18 Charrière is suitable as also is a Harris catheter (Figs 1040 1041) A stylet is sometimes necessary to introduce this into the bladder if the trigonal flap and the internal



Fig. 1040 —Tiemann catheter



Fig 1041 —Harris catheter

sphincter beneath it overhang the prostatic bed. If this method of drainage is employed the patient is kept dry irrigation is facilitated and the suprapubic wound closes more readily

Difficulties and complications arising during the operation and after treatment.—Freyer s operation is not easy in obese patients Fat on the buttocks makes it difficult for the rectal fingers to lift the prostate upwards and the thickness of the abdominal wall prevents easy access to it from above Small and adherent prostates in which the plane of cleavage is imperfectly developed are particularly difficult to enucleate especially if there are adhesions in the region of the seminal vesicles In all cases it is desirable for the enucleating fingers to keep as close to the gland as possible If this is not done the natural plane of cleavage is lost and the tissues surrounding the seminal vesicles are opened up so that these also become in part or in whole detached and it is necessary to cut through them with scissors This mistake not only makes enucleation more difficult but also increases hæmorrhage. Further it encourages the formation of sepsis by opening up unnecessarily large areas and leaving partially detached

tags of tissue. Very large prostates though easy to enucleate on account of the well-defined plane of cleavage which is always present are sometimes not easily delivered from the bladder and it may be necessary to bring each lobe separately on to the surface. These difficulties are partly overcome if a larger abdominal incision is employed. Tags of prostatic capsule which have become partially detached must be removed. This can usually be done with the fingers, or they can be twisted off with sponge holding forceps though this is not easy through the small incision of Freyer

The urethra is usually torn across without difficulty just above the level of the verumontanum. Every endeavour should be made to effect this Occasionally when the prostate is removed the whole of the prostatic urethra and a large part of the mucosa of the membranous portion are found to have been removed also In these cases it is particularly important not to omit the passage of an instrument about the tenth day and a watch should be kept for the possible subsequent formation of a stricture

Primary hæmorrhage—The surgeon should not be in too much of a hurry to close the wound. It is better to watch the case for a few minutes and, if the hæmorrhage does not diminish to pack the cavity with a roll of gauze. Two fingers are again introduced into the rectum and with the other hand the end of a roll of gauze 8 in. wide and several layers thick, is pushed down into the depths of the prostatic cavity after clots have been taken out until the space is tightly filled. Some surgeons have recommended filling the bladder cavity itself with packing as a means of keeping the first part in position but this is unnecessary and adds to the patient s discomfort by producing bladder spasms. The large suprapubic tube is then inserted The removal of the packing is begun in 48 hours and completed 24 hours later Though this is a valuable means of dealing with hæmorrhage it has the disadvantage that sepsis is encouraged by it particularly if the bladder was previously infected A hæmostatic bag is still preferred by some surgeons as being easier to introduce and is more effective. The type designed by Pilcher or Fullerton has been used as has also a large sized Foley catheter

Hæmorrhage may persist after the patient has left the table, or develop as *reactionary hæmorrhage* The first essential is to remove clots from the tube with long dissecting forceps. In every case a careful watch should be kept upon the patient s general condition, and the pulse counted every half hour The foot of the bed should be raised on blocks and morphia gr ¼ administered. If the bleeding does not abate the case should be taken back to the theatre promptly and the prostatic cavity packed. To effect this it is necessary to re-open the wound and remove the tube If the bladder contains clots these must be evacuated. Blood transfusion should be begun at once.

Summary—This operation has the advantage of simplicity and quickness and no special instruments are required. But the small

incision does not admit inspection of the bladder-cavity it also makes the operation difficult if the prostate is not easy to enucleate or the patient is obese the abdominal relaxation is imperfect or if the surgeon s fingers are short A longer incision of the abdominal wall and bladder will overcome many of these difficulties Freyer s operation has been widely practised with great success and remains a valuable procedure as a two-stage operation or when operation is necessary in isolated circumstances

Prostatectomy by open transvesical operation —H Harris was the first surgeon to devise a form of prostatectomy which was com bined with immediate closure of the bladder and the provision of catheter drainage.

Transvesical prostatectomy with closure (H Harris's operation) — The essential aims of this operation in the words of the late H. Harris are The immediate control of hæmorrhage by suture the reformation of the prostatic cavity combined with immediate closure of the bladder and abdominal wounds This operation com pletely obviates recurrences or post-operative obstruction. *

Special instruments.—Boomerang needle-holder (Fig 1024 p 2347) self retaining illuminated bladder retractors and suture carrier (Fig 1029)

Operative technique.—The bladder is thoroughly washed and emptied, and the urethra irrigated A transverse incision is made through the skin and fat 2½–3 in. in length and 1 in above the symphysis pubis The rectus sheath is opened vertically and the recti separated. The bladder is opened at the highest point and the prostate enucleated Two fingers are introduced into the rectum as described in Freyer s operation (p 2371) Harris employed the method of enucleation first described by Bently Squier When the prostate has been delivered a self retaining retractor is introduced (Fig 1004) Attention is now given to the prostatic rim Tags are resected and individual hæmostatic sutures are inserted in the posterior parts of the prostatic inlet particularly at points about 30° right and left of the middle line using the boomerang needle-holder fitted with the smaller-sized needle (Fig 1025) On each side one of these may be left long and held in pressure forceps to lift the prostatic rim and thus facilitate the insertion of succeeding sutures Every endeavour is made to control hæmorrhage from this region but this cannot always be easily done

Retrigonization. —For this the larger needle is used in the boomerang needle holder It is entered at the deepest part of the *bas fond* behind the inter ureteric bar (Fig 1042) The point of emergence of the needle is well down through the floor of the prostatic

* Harry Harris, Prostatectomy with Closure, *B r Med. Journ.*, Jan., 1934, i, 434

cavity and as the handle of the holder is compressed the needle-point emerges in the middle line at the prostatic inlet. The suture carrier equipped with a piece of No 1 plain catgut about 14 in long is brought into contact with the needle and the catgut engaged in the

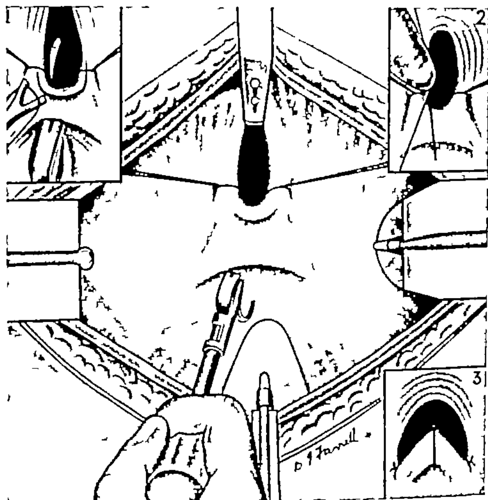


Fig 1042.—Retrigonization of the prostatic urethra. The main figure shows the point of entry of the needle in the bladder base well down behind the inter ureteric bar

Inset 1 shows the point of emergence of the needle well forward in the prostatic cavity and the suture carrier approaching the needle. *Inset* 2 shows the retrigonization suture being tied, with the forefinger of the left hand pressing the loop well down into the prostatic cavity *Inset* 3 shows the retrigonization suture tied, sewing the trigone well down into the prostatic cavity, both obliterating the ledge in that situation and re-forming, at least in part, the new prostatic urethra. Two hæmostatic sutures only are illustrated in all figures for the sake of simplicity

slot then the needle bearing the thread is withdrawn from the wound. The suture is tied by a running knot with the point of the index finger of the left hand This is pushed well down into the prostatic bed. Two more knots are then added, the first tightening up the running knot the second securing it Before inserting this or any other suture at the edge of the prostatic fossa, either for hæmostasis or for recon-

struction it is essential to be certain of the exact position of each ureter It is claimed that by this suture the trigone is brought well down into the prostatic bed and thus re-forms the floor of the prostatic urethra.

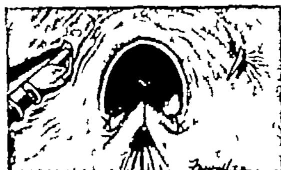


Fig 1043 —Needle in position for the first anterior transverse obliterative suture.

Note width of bite of needle. Trigonal tongue in position. For simplicity only two hæmostatic sutures are shown.

Anterior obliterative sutures.—Using the large boomerang needle the point is entered on the left side 1–1½ in from the free edge of the prostatic rim depending upon the size of the cavity (Fig 1043) While this is being inserted the handle end of the needle-holder is in a combined movement swung from the opposite edge of the wound towards the side of the operator and the spring compressed thus causing the point to emerge at a similar site through the bladder mucosa on the right side of the prostatic inlet When inserting this the needle-holder should be kept in a nearly vertical plane because if used in a more horizontal position there is a risk of picking up the triangular ligament and injuring the compressor urethræ. It may be necessary to push slightly upon the mucosa to cause the point of the needle and the slot in it to appear above the tissues The suture-carrier equipped with a 14-in. length of No 1 plain catgut is now engaged in the needle-slot. Synchronously the spring handle and suture-carrier are released. As the needle retraces its course the hand is swung across to the right side of the wound This movement combined with a series of light jerks is usually sufficient to allow it to be withdrawn. This first suture passes transversely at a tangent to the anterior segment of the prostatic rim A second is introduced parallel to the first and bisects what remains of the prostatic cavity (Fig 1044) These sutures may be embedded in the anterior wall of the prostatic fossa or traverse the prostatic cavity deeply from side to side just missing the floor in its depths. They will lie above and in front of the catheter when it is passed Very rarely a third suture may be required. When they are tied no raw surface is visible though the prostatic urethra should always be left open wide enough to admit the tip of the first finger

A special thin walled rubber catheter with two eyes size 22 Charrière is introduced. Some difficulty may be experienced in passing it into the bladder and it may be necessary to thread it over an introducer The tip is cut off and the lip transfixed with a long strand of medium thickness silkworm gut or nylon the ends of which are brought to the surface of the wound and temporarily secured in a pressure forceps The bladder is now swabbed out and if hæmorrhage has been adequately controlled may be completely closed the ends of the strand of

silkworm gut alone coming out through it to the surface this is adjusted to maintain about 1 in. of the end of the catheter including both eyes within the bladder-cavity At the end of the operation the catheter suture is tied round a small metal or glass rod which lies upon the skin. Before leaving the table the catheter is syringed out to remove blood-clot The end is inserted into a sterilized 8-oz. glass

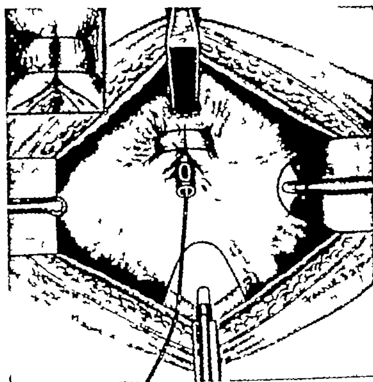


Fig 1044 —Second transverse obliterative suture inserted plastic operation completed. The catheter with silkworm-gut transfixion suture, is in position. It is passed intact and the tip cut off after second eye has been made.

Inset —Same stage before passage of catheter Note that there is no visible raw surface, that the trigonal flap lies on plane below that of the rest of the bladder base and is firmly bedded in position, and that the lateral edges of the prostatic bed are deeply inverted, thus partly re-forming the side walls of the new prostatic urethra.

bottle When the patient is returned to bed the catheter is connected up by a length of rubber tubing leading to a bottle at the bedside with the end of the tubing dipping under the surface of an antiseptic solution. Unless hæmorrhage has been adequately controlled the bladder should not be completely closed but should be drained suprapubically through a Winsbury White or de Pezzer tube

Wilson Hey's Operation*

In 1945 Wilson Hey described an operation of almost total prostatectomy which included trigonectomy and which he claimed to be the simplest easiest and safest operation yet devised Although strongly supported by some surgeons his operation has not appeared to fulfil all that he claimed.

* W A. Hey 1946, Brit. J Surg., 33, 41

Special instruments required are an illuminated bladder retractor and diathermy hæmostat

The bladder is opened and examined. A soft bougie with a long nylon thread attached to its thicker end is passed through the internal meatus and retrogradely through the penis and withdrawn leaving 6 in of nylon in the bladder and on the towels at the lower end of the wound. A clip is applied to the part of the thread which has come out of the external meatus so that it cannot be accidentally drawn back into the bladder Next the prostate is enucleated with the aid of a finger in the rectum being cleared except at the urethral and bladder ends Every endeavour is made to remove the potential cancer bearing areas between the true and false capsules. The surgeon then changes gloves and gown The patient is put into the full Trendelenburg position retractors are inserted and illumination of the prostatic bed is arranged.

A probe is passed into each ureter With a diathermy needle and using coagulating current the trigone is excised to within ¼ in of each ureteric orifice. The entire margin of the prostatic inlet is also excised together with the inter ureteric bar thus freeing the prostate at its vesical surface. The vesicles are either cut through or entirely removed. With the needle the prostatic urethra is divided about ¼ in above its junction with the membranous urethra care being taken not to cut the guiding nylon thread lying within it. The prostate thus freed is removed The prostatic bed is now examined and each bleeding vessel is individually coagulated. For this purpose and throughout the operation a Wilson Hey diathermy hæmostat is used this is a pair of finely pointed artery forceps with a screw clamp socket which provides connection to a cable from the diathermy machine this same pair of forceps holds the needle used for cutting purposes. Tags loosened pieces of false capsule and separate adenomata are removed with scissors and diathermy No ligatures or sutures within the bladder are permitted. When clots have been cleared away and the cavity is nearly dry 5 per cent solution of sodium citrate is run into the cavity A thin (1 mm) walled rubber tube 5 to 6 mm in diameter is used to provide drainage for the bladder It is drawn into position retrogradely by the following method. A thread is stitched through what is to be the outer end of the tube and tied this thread is passed through the lumen of a medium-sized rubber catheter from the funnel end along to the tip so that when this thread is pulled upon it draws the end of the urethral tube into the shelter of the funnel. This tube and catheter are prepared ready for use before the operation The thread coming out of the nose of the catheter is attached to the bladder end of the nylon thread which was introduced into the urethra at the beginning of the operation. The clip at the external urinary meatus is now pulled upon this draws the nylon along the penis outwards through the urethra, followed by the rubber catheter followed by the drainage tube This has two eyes cut in it and is so placed that one eye is in the bladder and the other in the prostatic bed. Wilson

Hey considers that this method of retrograde introduction of the tube prevents infection spreading upwards from the urethra to the prostatic region and bladder

The bladder wall is now closed by three layers of No 0 catgut. The first is a continuous suture and picks up the musculature of the bladder but neither this nor the succeeding sutures penetrate the mucosa its end is left long Next four or five interrupted sutures are inserted between the turns of the previous suture. The first suture is then resumed to cover the previous ones by unfolding them. The abdominal wall is closed drainage being provided by a tube for 24 hours. The urethral tube is fixed by a suture through the prepuce. The bladder is emptied through the tube and when 10 oz. of 5 per cent. sodium citrate solution have been inserted the tube closed with a spigot.

After-treatment.—The patient is kept flat in bed for the first few hours. The spigot is removed after two hours. If the tube is found to be blocked ½ oz. injections of citrate solution are used to clear it aided by suction If this fails the tube must be removed. The tube is usually removed on the second day and micturition then commences If necessary in special cases carbacol morphia and hot baths may be used to induce micturition Only as a very last resort must a catheter be passed. The reaction of the urine must be frequently tested and steps taken to keep it acid. The patient gets up on the day following the operation The suprapubic wound, after removal of the drains is not dressed until the tenth day when the sutures are removed and the patient normally sent home.

ENDOSCOPIC RESECTION OF THE PROSTATE

1 With the resectoscope.—The Stern McCarthy model with or without modification is that which is generally employed (*see* Fig 1013 p 2386)

The **resectoscope** is a somewhat complicated instrument and it is essential to know precisely how to assemble and sterilize it and to be familiar with its workings so that the necessary movements can be performed almost automatically The diathermy machine must be of reliable manufacture All connections and switches must be in good order The general arrangement of this apparatus of the irrigator and of the patient should be as described for cystoscopic diathermy of bladder growths (*see* p 2887) except that a cutting current of greater strength and preferably a valve machine is required. Care must be taken to avoid over-distension of the bladder and the reservoir of the irrigator must not be more than 2 ft above the patient. The surgeon operates sitting or standing provided that the table can be raised to the necessary height

The resectoscope is entirely dismantled and sterilized by soaking in 1 1 000 oxycyanide of mercury solution After use it should be well washed under a tap and wiped over with soap and water and the interior of the sheath similarly cleaned to remove all grease before

drying Spirit if used should not be applied to the varnished parts Coagulating electrodes and spare loops should be kept at hand sterilized and it is desirable that a complete spare resectoscope should be available Other equipment which is required during the operation is a set of metal dilators a bladder syringe a suction syringe or Ellik evacuator with a fitting to adapt it to the resectoscope sheath Suitable catheters and an introducer will be required at the end of the operation.

Technique.—To ensure that the urethra is adequate in size metal dilators are passed to a size slightly larger than the resectoscope If the meatus is small meatotomy is performed. The resectoscope is well lubricated with one of the water soluble preparations since if paraffin is used it is difficult thoroughly to cleanse the instrument at the conclusion of the operation and the telescope becomes clogged. After the beak has passed the compressor urethræ the ocular end of the sheath must be fully depressed often until it is well below the horizontal plane. Unless this is done the beak is apt to penetrate the prostate an error which may make its introduction impossible and which produces laceration and bleeding greatly obscuring the field of view

The obturator is withdrawn and urine flows out of the bladder The inflow tube leading from a reservoir and the outflow tube draining into a bucket are joined to the sheath Preliminary washing can be done with a syringe or from the irrigator water being run in while the end of the sheath is closed with a finger but little time should be spent on this If a preliminary cystoscopy has not been carried out it must be done now The best resectoscopes have right angled and retrograde telescopes in addition to the fore-oblique one used for the actual operation. After examination of the bladder has been completed, the loop-carrier fitted with its fore-oblique telescope is introduced. The line of sight is inclined to an angle of 15° from the long axis and with this a much better view of the prostatic urethra can be obtained. There are two important landmarks the identity of which must be established with certainty These are the verumontanum and the internal urinary meatus

The verumontanum is important because that part of the prostate which forms an obstruction to urinary outflow lies above it Neither in resection nor in prostatectomy by other methods is it necessary except in rare instances to remove any portion of the gland below this level posteriorly although obstructing tissue may be found lateral to it. Above the verumontanum in the middle line the prostate is sometimes thin particularly in median bar cases and if during the process of resection too much tissue is removed from this region there is serious risk of opening up the cellular spaces behind it Furthermore if the verumontanum is accidentally destroyed the operator may find that owing to loss of this landmark he is cutting too far down the urethra and thereby risking injury to the compressor muscle If this is damaged incontinence of urine may result

The internal urinary meatus may undergo various degrees of distortion in prostatic enlargement The operator should, therefore study it closely in all aspects before resection is commenced. If the degree of hypertrophy is slight the inter ureteric bar may be visible in the same field as the intravesical prostatic projection although when the latter is more developed the bladder base is completely screened by it Those who are inexperienced in the use of the fore-oblique telescope may find difficulty in distinguishing between these two important landmarks the view being much fore-shortened so that the inter ureteric bar and the ureteric orifices appear much closer to the internal meatus than when seen through the right angled telescope of the ordinary cystoscope. On this account serious errors have been made and when the inter ureteric bar has been mistaken for the intravesical projection cuts have been made with the diathermy loop which have penetrated through the bladder wall If in doubt as to these land marks the operator can be sure that he is viewing the internal urinary meatus by noticing that if the instrument is withdrawn a little the only view obtainable will be of the posterior urethra, and if the water inflow is shut off, even this is lost for the walls of the passage collapse upon the objective. On advancing the instrument again by the same amount the margin of the internal meatus once more comes into view By rotating the instrument this can be traced round until the anterior "V" notch which is characteristic of intravesical prostatic enlargement comes into view This is found at 12 o clock in cystoscopic terms or slightly to one side of it. The instrument is now again rotated, keeping the margin of the internal urinary meatus in view until 6 o clock is reached If the instrument is now pushed slightly into the bladder and the ocular end is raised the inter-ureteric bar will in many instances come into view and, once identified in this manner it should not again be confused with the prostatic margin. The operator must not lose his bearings in relationship to either the vesical neck or the verumontanum and if at any time during the process of resection he is in doubt he should make a careful check. It is sound practice to complete the resection of one side of the prostate before treating the opposite side thus the identity of an important landmark is preserved as long as possible

Until therefore the surgeon feels certain that he possesses an intimate knowledge of the appearances of this part of the urinary tract as seen through a fore-oblique telescope and, moreover that he can use correctly the water irrigation which forms such an important part of the system, he will be well advised not to undertake endoscopic prostatectomy For his first attempts he should choose cases in which the obstruction is small, where hæmorrhage may be expected to be slight and when a skilled endoscopist is available for consultation.

When dealing with an obstruction which is confined to the middle lobe or is due to a muscle bar obstruction resection may begin at the posterior commissure just to one side of the mid line. The instrument is placed so that the verumontanum is just in view and the loop is

wound out so that it engages the middle lobe The current circuit is completed the levers wound back and the first cut completed. At the end of the cut the current circuit must be broken promptly so as to minimize the risk of burning the sheath The tissue should float into the bladder the trough made is inspected and a further strip cut off in the same region The base of the fissure is inspected after each cut to determine whether or not the capsule of the prostate has been reached. This is indicated by a change in the appearance of the tissue The prostate itself looks rather fluffy the capsule is white and its fibres can be distinguished as being interwoven and rather pearly Any spurting vessel is coagulated by very short application of the loop When the capsule has been reached the instrument is rotated slightly laterally so that the contiguous tissue may be dealt with in the same way Not infrequently and especially when a stop-gap machine is being employed the strip of tissue does not float into the bladder but remains stuck to the loop The carrier should then be withdrawn from the sheath and the strip removed If this tissue is floating easily into the bladder care must be taken not to allow over-distension and fluid should be removed from time to time At intervals and at the end of the operation all tissue is removed with a suction syringe the Ellik being particularly suitable

It is sound practice to deal with hæmorrhage at the earliest possible moment. Whenever therefore the making of a cut divides a vessel which is of sufficient importance to spurt continuously and thereby to impair visibility it should be at once sealed off unless it is the operator s intention to make another cut in the same region which must inevitably open up the same vessel. Delay in doing so may cause the medium to become so blood-stained that it becomes very difficult to find the vessel In treating bleeding of this type the loop should be wound forward until it is brought into light contact with the spurting vessel. If this is done with accuracy a momentary pressure upon the foot-switch will seal it. No attempt should be made to coagulate deeply or widely

If hæmorrhage is treated in this way a reasonably clear field can be maintained throughout the operation and at its conclusion less time has to be spent in a search for vessels which have been left unsealed in the hope that bleeding would cease spontaneously It is sometimes impossible to coagulate larger vessels with the loop and it then becomes necessary to substitute a ball electrode. If this is used the intensity of the current should be reduced To employ this type of electrode the carrier has to be withdrawn to fit it and sometimes by the time it has been re-introduced there may be considerable difficulty in locating the artery even though its position had before been accurately determined. This is a further reason for using the loop to deal with each vessel soon after it has been first cut. It may be thought that this entails a loss of time but the relatively clear field which obtains throughout the resection greatly facilitates each successive step and thereby shortens the total duration of the operation

Moreover the loss of blood is greatly reduced. The ball electrode is sometimes useful in coagulating veins for unlike arteries they tend to retract into the tissues and it is therefore difficult to bring the loop into contact with them.

Hæmorrhage occurring during the operation should never be allowed to become so severe as to obscure its origin. The importance of dealing with spurting vessels at an early stage even though they may sometimes be difficult to locate has already been stressed. If for any reason the hæmorrhage is considerable the first step is rapidly to empty the bladder of clot and for this purpose irrigation with a suction syringe is most effective As soon as this has been done the carrier preferably fitted with a ball electrode in place of the loop is re-introduced. A systematic search is begun and carried out as quickly as possible Water is run in fast enough to gain a clear medium and the instrument with the objective kept close to the resected surface, is moved slowly backwards and forwards to examine the whole area which has been resected. When a blood vessel is met the inflow should be reduced or momentarily shut off for if left at full strength such turbulence of the blood stained medium is produced that the source and intensity of bleeding are difficult to estimate. This is particularly the case when two or more arteries are bleeding at the same time In difficult cases it may be necessary to maintain a steady inflow until the bladder is distended a process which will often reduce the bleeding by the increase of hydrostatic pressure which results. The bleeding points can thus as they fade out be identified and sealed. This is a process to be used with caution and for as short a time as possible for the irrigating fluid may become forced into the circulation Excessive and indiscriminate coagulation should be avoided as it leads to undue necrosis of tissue. Very occasionally the bleeding may be so severe that the source cannot be ascertained, although as the surgeon gains experience the likelihood of this happening becomes remote In such cases the operator has to decide how much time may reasonably be devoted to the attempt If in doubt he will be well advised promptly to adopt some other measure such as cystotomy and local pressure In such cases a Foley catheter by itself will be of little if any use it is valuable however when, after the bladder has been opened it is inflated fully surrounded with a layer of gauze and pulled down into the prostatic region

Venous bleeding though it may be serious if a cut has penetrated into a plexus is not usually of great importance but if a vein of considerable size is opened the arrest of hæmorrhage may be less easy than from an artery for whereas arterial blood can be seen to issue from a minute and sharply defined puncture that of a vein comes from a larger opening and one which tends to retract into the tissues. The sealing by coagulation of such a vessel is for these reasons often difficult particularly when as sometimes happens even slight pressure near to it with the electrode momentarily stops the bleeding In all cases when sufficient tissue has been resected the operator must

be satisfied that the control of hæmorrhage is adequate The water which returns when the bladder is irrigated should not contain more blood than will make it faintly pink If it is heavily coloured there is a serious risk of clot retention In such cases a further search must be made for bleeding vessels which when found should be sealed by coagulation

Nesbit's three-stage operation.*—Nesbit has evolved a plan of operative technique for dealing with larger glands which he divides into three stages. In the first the main bulk of tissue between the internal meatus and external sphincter is removed In the second stage the tissue remaining in the concavity of the prostatic fossa is resected, and in the last stage any tissue which may have been left at the apex is dissected off

Technique.—The first cut is made to one side of the anterior cleft and extends the whole length of the prostatic urethra. The strip falls back into the bladder the furrow is inspected and any bleeding points coagulated. The depth of the cut is estimated If prostatic tissue remains a further cut is made but if the capsule has been reached the resectoscope is rotated slightly so that the next cut can be made contiguously When this is resected and extends to the region of 4 or 8 o clock the operator changes to the other side which is dealt with in a similar manner There now remains a considerable part of each lateral lobe and the whole of the middle lobe As the blood supply to these areas has been to a large extent cut off the tissue can be resected more easily as there is not as a rule a great deal of bleeding Care must be taken not to cut a strip of tissue which is too large to pass through the resectoscope. Should this happen however the tissue may be caught in a loop and drawn out or if this should fail it may be removed with the Lowsley biopsy forceps When the intravesical projection has been removed and the bladder neck exposed the remainder of the middle and lateral lobes are removed each strip beginning just distal to the bladder neck The furrow is deepened until the capsule is identified and systematically rotating the resectoscope the prostatic fossa is cleared Nesbit advises that this stage should be completed with a finger in the rectum although other able resectionists such as Milner do not think that this is necessary There is always a danger of producing an opening in the capsule and great care must be taken to avoid cutting too deeply

In Nesbit s third stage the tissue near the apex is resected and here great care must be taken not to resect distal to the mucous membrane fold which indicates the level of the external sphincter There is no prostatic enlargement in the mid line posteriorly below the verumontanum and thus serves as a most valuable landmark on this aspect but there may be quite a lot of tissue laterally which requires to be removed Milner considers failure to remove this tissue to be a more common cause of incontinence after resection than injury to the external sphincter When removal is complete the whole fossa is

* Nesbit, R. M. 1954, Campbell's Urology p. 2014.

examined so that no spurting vessel is overlooked Coagulation may be effected with the loop or with a special ball electrode. Occasionally a venous space in the periprostatic plexus is opened into and may be difficult to deal with It cannot be stopped by diathermy but will usually clot over if left for 5 minutes Such bleeding should be suspected if there is a considerable blood loss and no spurter can be seen. In this eventuality the resectoscope should be removed a Foley catheter passed and nothing at all done for 5 minutes. At the

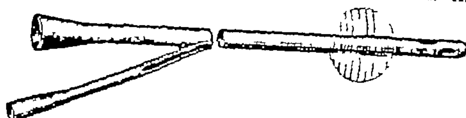


Fig 1045.—Foley s catheter

end of this time it will be found that bleeding from the venous space has stopped. When satisfied that sufficient tissue has been removed and that bleeding is adequately controlled a 22 Charrière Foley catheter (Fig 1045) is left in the bladder irrigated and the patient sent back to the ward on free drainage

2. **Resection with the cold punch.***—When the punch has been introduced the bladder is examined to exclude the presence of neoplasm, large diverticula or stones The degree of hypertrophy of the bladder musculature and the inter-ureteric bar is observed and the ureteric orifices visualized and their position noted. The degree of intravesical enlargement of the middle and lateral lobes is determined and the instrument is slowly withdrawn into the prostatic urethra. The middle lobe, if enlarged, will project forwards and later the lateral lobes will fall in from the sides leaving a vertical slit between the lobes (Fig 1046) The degree of obstruction can thus be seen and the size of the prostate determined The final view should be made with the instrument just distal to the verumontanum which should be clearly seen as this structure acts as a landmark throughout the operation and may be regarded as the guardian of the sphincter

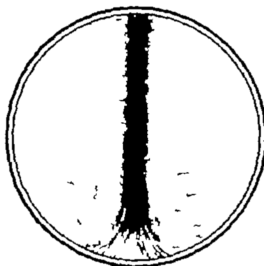


Fig 1046 —Enlarged prostate (see text)

The resection is now commenced at the position 1 or 11 o clock,

* This section with Figs 1046 and 1047 was kindly contributed by Mr. H. Hamilton Stewart.

according to the first lobe to be removed (Fig 1047) The surgeon by resection of tissue cuts a path around the periphery of the lateral lobe as though he were enucleating the lobe with the finger in the open operation. The main bleeding points are controlled by coagulation with a fine electrode A similar procedure is then carried out on the other side. In this way the lateral lobes are devascularized to a great extent and as they fall back their excision is made easy The middle

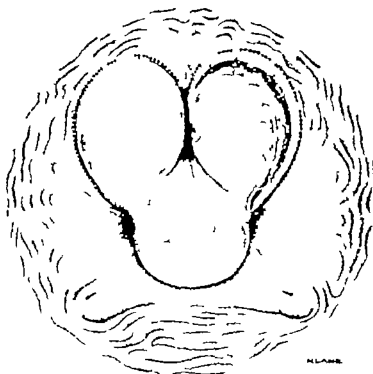


Fig 1047 —Resection of prostate (see text)

and lateral lobes are now resected Towards the end of the operation the assistant places his right index finger in the rectum and lifts forwards remnants of the lateral lobes so that resection can be completed

The aim in benign enlargement should be to remove prostatic tissue down to the true capsule which can be recognized by its pearly white circular fibres. Cutting into the true capsule must be avoided as it may result in (*a*) hæmorrhage from venous sinuses difficult to control (*b*) entrance of irrigating fluid into the venous circulation with resulting hæmolysis—isotonic fluid must be used if this complication occurs (*c*) extravasation It should also be remembered that the verumontanum should be preserved throughout the operation as it serves as a landmark to locate the position of the sphincter The proximity of the verumontanum to the sphincter varies in individual cases and the operation must not be completed until the prostatic cavity has been viewed from the sphincter In this way the surgeon ensures that the apical lobes have been completely removed.

During the time that cutting is in progress a constant stream of

water is allowed to flow through the instrument into the bladder When the bladder is full (no more than 15 oz should be introduced) it is drained by opening the stop cock at the end of the instrument and many pieces of cut tissue escape and are collected in a sieve.* At the end of the operation the eye piece is removed and any pieces of tissue which remain in the bladder are withdrawn by aspiration by means of a large syringe and finally a catheter usually of the Foley type is introduced and left *in situ* to drain the bladder

After treatment.—For the first 24 hours after perurethral prostatectomy it is essential that a very careful watch should be maintained to ensure that drainage is continuous If hæmostasis has been effective and the catheter is in good position there should be no difficulty The nurse must however satisfy herself that the catheter drains continuously This is usually done through a length of sterilized tubing leading to a receptacle beneath the bed. If in doubt this tubing should be disconnected a clean vessel should be placed under the catheter and if after ten minutes no urine has run into it it is obvious that the catheter is either blocked or out of position and steps must be taken to remedy this If the fault is one of position gentle pushing of the catheter into the bladder will probably produce a gush of blood tinged fluid. If it is due to clot prompt suction with a syringe usually re-establishes drainage Small quantities should be used, not more than say 2 oz at a time but these should be vigorously injected with a good syringe in order to clear the catheter from clot.

Difficulties and complications. (1) *Destruction of landmarks*—The verumontanum will be coagulated or resected if care is not taken always to end each cut above it Whenever it has been inspected the sheath must be again advanced sufficiently to cover it If this landmark is inadvertently destroyed and similarly if the position of the vesical neck is not constantly memorized the surgeon may be led into further troubles.

(2) *Reactionary hæmorrhage and clot retention*—It has already been emphasized that no patient should be allowed to leave the operating table until adequate hæmostasis has been effected and all clot has been washed out of the bladder The need for constant observation of every case of perurethral prostatectomy during the hours immediately following the operation has been pointed out. In some cases however in spite of all precautions blood clot will accumulate in the bladder owing to persistent oozing or reactionary hæmorrhage may bring about the same result In such conditions the catheter does not drain freely lotion injected with a syringe is not recovered, and the bladder presently forms a palpable tumour above the symphysis pubis. The first step is to change the catheter and when a fresh one has been inserted to clear the bladder by suction with a syringe this must be of good quality and capable of producing a powerful effect. It may be necessary to change the catheter more than once during the

* The outlet tube can be connected to a trap fitted in the neck of a large glass container (carboy). Negative pressure obtained in the container by a strong suction pump will ensure that water and prostatic tissue are aspirated quickly from the bladder The tissue collects in the trap.

process and to inject fluid in small amounts say 2 to 4 oz forcefully as well as to apply suction Usually such methods are successful and in many cases now that the bladder is empty no further serious hæmorrhage occurs If this fails to empty the clot the patient is returned to the theatre anæsthetized and the clot removed with a Bigelow s evacuator If hæmorrhage persists cystostomy should be performed the bladder emptied of clot and drained

Secondary hæmorrhage may occur but it is not common and then is usually not severe and ceases with rest in bed and diuresis If clot retention occurs it is dealt with as in (2)

(3) *Sepsis* —Some sepsis in the area of resection may occur as a result of the diathermy but is not necessarily important and danger of it is considerably lessened if diuresis is maintained and sulphonamides administered The urine after resection is commonly turbid for some days or weeks and contains shreds It gradually clears as healing of the resected area occurs Persistent infection may result from the continued presence of residual urine or from imperfect resection which leaves portions of the prostate traumatized and with a damaged blood supply

(4) *Perforation of the prostatic capsule* occasionally occurs even when the operator is fully experienced. In such cases it is usually promptly recognized through the telescope If minute the perforation may lead to no harm but if suspected the patient is carefully observed for the next 48 hours. If the temperature begins to rise and if there is tenderness above the pubic ramus an incision should be made through the abdominal wall and drainage of the cave of Retzius established If much extravasation has occurred a cystostomy should also be done If one is certain at the time of operation that a large gap has been made in the capsule it is wise to do a cystostomy straight away

(5) *Epididymitis* is less likely to follow this operation than that of enucleation. Preliminary division of the vas will nearly always eliminate it.

(6) *Stricture formation* —It is always a possible complication if the urethra has had to be dilated Any undue narrowing of the canal should be considered a contra indication to perurethral prostatectomy and the method should be abandoned if difficulty is encountered in the introduction of dilators or the resectoscope Some urologists introduce the resectoscope through a perineal incision made into the bulbous urethra thus avoiding injury to those parts which are particularly susceptible namely the external meatus the fossa navicularis and the anterior portion of the penile urethra If a stricture forms it is likely to be severe therefore a careful watch must be kept if it is considered that there has been any risk of injury to the urethra such as might lead to this occurrence Post-operative meatal stenosis is not uncommon and will require treatment by intermittent dilatation

(7) *Injury to the membranous urethra* —If this is more than very slight and even if only a small arc is damaged permanent incontinence is likely to result from interference with the function of the compressor urethræ

Post-Prostatectomy Obstruction

Obstruction may occur at the neck of the bladder after prostatectomy. It is most commonly due to fibrosis from infection with or without a trigonal flap. It may be due to inadequate removal of the original obstruction or at a later date, to further benign or malignant changes in the prostatic capsule. A stricture may form at the external meatus or just in from it especially if the orifice was narrow from the outset. A stricture may form anywhere along the urethra from injury due to the passage of too large an instrument. A stricture may form in the membranous urethra if part of it has been injured at the time of the enucleation.

Fibrous contraction may follow any form of prostatectomy *though its occurrence is greatly diminished if a wedge of tissue is excised* from the trigonal flap. The internal meatus may be completely obliterated; more usually it is reduced to the size of a small probe. The opening may be displaced and most frequently this is in a downward direction so that it comes to lie under the pubic arch and is therefore not visible through a cystotomy incision. A ring of dense fibrous tissue often surrounds it. The condition should be suspected if the patient reports that the urinary flow is no longer as full as when micturition was first re-established, when there is considerable delay in the healing of the suprapubic fistula, or if this re-opens from time to time. It is frequently accompanied by chronic cystitis which instead of diminishing as the interval after the prostatectomy lengthens, either remains constant or becomes worse. Lack of control of micturition leading to wetting of the clothes also calls for investigation of the urethra. Instrumental dilatation is usually effective in treating the less severe degrees of such obstruction. Steel or flexible bougies should be tried and in some instances those of the Benqué pattern will enter the bladder when others fail. If dilatation can be effected it should be continued at extending intervals and the condition may thereby be cured. It should be accompanied by bladder irrigation. If the opening is much contracted it will not be possible to pass a bougie into the bladder by ordinary means and operative treatment is required. This should be done if possible endoscopically otherwise the bladder will have to be opened.

Diathermy incision through a posterior urethroscope.—The patient is anæsthetized and placed in the lithotomy position. A panendoscope (*see* Fig 1014, p 2886) of size 24 Charrière (14 English) is introduced until a resistance is encountered. No attempt is made to pass the instrument farther and every care should be taken to avoid producing hæmorrhage. The pilot is now withdrawn, the telescope introduced and the water inflow tap opened. By manipulating the instrument and gently advancing it and particularly by depressing the eye-piece, a view is obtained of the narrow opening into the bladder at the top of the prostatic fossa. The inflow is then shut off until the operator is

quite ready to use the diathermy for a view is only obtainable while the water is running through the cavity and when once the bladder is filled the flow becomes sluggish A Collings s diathermy knife (Fig 1048) is passed through the sheath of the panendoscope and attached to the appropriate lead The diathermy is set to a moderate degree of cutting current. When all is ready the inflow tap is re-opened and the blade of the knife pushed forward to enter the opening into the bladder or if this is not possible it is brought into contact with its posterior margin The current is switched on for a moment and the blade of the Collings s knife thus activated is made to cut through the tissues in a posterior direction for about ½ in This distance may be exceeded but only when it is seen clearly that the opening into the bladder has been displaced forward and that there is a large overhang of fibrous tissue at the top of the prostatic fossa for the rectum has been wounded by excessive cauterization Other cuts may be made laterally in a similar fashion and the opening enlarged sufficiently for the panendoscope to enter the bladder When the bladder has been examined and washed out the instrument is withdrawn and metal dilators are passed and a 20 Charrière catheter is tied in By this method the great majority of post prostatectomy obstructions can be treated and when once fully dilated can be so maintained by instrumental dilatation at increasing intervals After such treatment the patient may occasionally suffer from incontinence sometimes to a severe degree but recovery is usually complete and seems to depend on the gradual absorption of the scar tissue surrounding the upper part of the urethra Should the obstruction recur after dilatation a resectoscope is passed and several strips of scar tissue are removed

Open operation for obstruction is sometimes necessary and is often the best method if there is a persistent suprapubic fistula which needs excision The bladder is widely opened and a retractor introduced In most instances the narrowed outlet into the urethra is seen If it is not obvious or if it has been completely obliterated, a steel bougie should be passed through the penile urethra until its point begins to lift up the lower part of the trigone thus showing the degree of displacement of the opening This also indicates the extent to which it is necessary to enlarge the opening if one is present or where to make a fresh exit if the bladder base is completely closed. Cutting is best done with a diathermy needle or with a long handled knife with a small blade and in a backward direction but should not be carried too deeply for the rectum lies close beneath this region It may be necessary to excise a dense mass of scar tissue to obtain an adequate channel. In some instances as already stated, the internal meatus of the bladder has been pushed so far downwards and forwards that it is out of sight beneath the pubic arch A steel bougie in the urethra is, however a guide to its position and upon the point of this an incision should be made In all cases full-sized dilators i e. as large as can be passed through the external meatus should be passed and a catheter placed in position while the retractor is still *in situ* —If

bleeding and sepsis are slight the bladder may be closed by primary suture. In other cases a small suprapubic tube of the de Pezzer type is required for a few days Open operation will also be employed if calculus formation in the prostatic fossa or in the bladder complicates post prostatectomy obstruction.

CHRONIC PROSTATITIS

Only in exceptional cases will surgical treatment be employed in this condition but if the patient is liable to recurrent attacks of acute inflammation of the gland associated with fever and possibly rigors and posterior urethroscopy reveals one or more dilated duct from which purulent material exudes a valuable method of treatment is to lay *these open by means of a Collings s knife (Fig 1048) through*

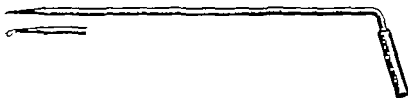


Fig. 1048 —Collings s knife

a panendoscope *This must be done with caution, but the incision* should be adequate to drain the granulation lined cavity with which the duct communicates The portion of the gland *lying between this* area and the vesical neck should also be incised The operator should not attempt to do too much at one session and should be prepared if necessary to repeat the procedure after an interval of some weeks. It may be that a similar effect can be obtained by resecting part of the prostate endoscopically

Radical Prostatectomy

The term prostatectomy as generally applied is a misnomer Freyer and some of his contemporaries believed that at his operation the whole gland was removed This was shown to be incorrect as early as 1907 by Cuthbert Wallace but the name prostatectomy still continued to be applied to the operation There are certain pathological conditions which may necessitate the removal of the whole gland —

(1) **Carcinoma,** which has not spread *through the capsule.* It is exceptional (less than 1 per cent.) for the disease to be encountered at *this stage* in this country

(2) **Calculus disease of the prostate.**—Stones are present in many prostate glands If these give rise to symptoms and if it is not possible to remove them endoscopically a subtotal prostatectomy may be done leaving a small cuff of capsule at the apex.

(3) **Recurrent focal prostatitis**—If this gives rise to much constitutional upset especially if complicated by attacks of iridocyclitis or subacute arthritis a total prostatectomy must be contemplated This operation carries a great risk of impotence and a considerable risk of incontinence These complications should be put to the patient and the 'pros' and 'cons' discussed with him In clinics where perineal prostatectomy is a common operation it may be advantageous to perform it through this route Otherwise the operation is simpler through the retropubic approach as described by Millin

Technique.—A Tieman's No 18 rubber catheter is passed into the bladder The bladder is emptied and the catheter is left in place

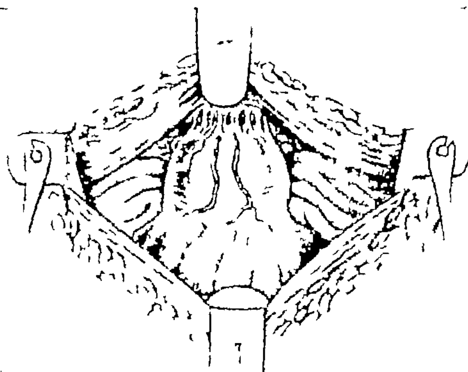


Fig 1049.—Radical retropubic prostatectomy Exposure of the prostate and pubo-prostatic ligaments.

The retropubic space is exposed as on p 2365 and superficial vessels are under run and divided or coagulated The fat in front of the surface of the gland is gently cleared and the pubo-prostatic ligament exposed, divided and ligated. The index finger and thumb of the right hand now free the gland on the right side and bring the apex forward together with the membranous urethra which is easily identified by the indwelling catheter The line of cleavage between the back of the apex of the prostate and the rectum is gently sought by the tip of the index finger and the prostate and urethra are freed and partly lifted into the wound An incision is made in the anterior part of the capsule of the prostate In dealing with malignant disease

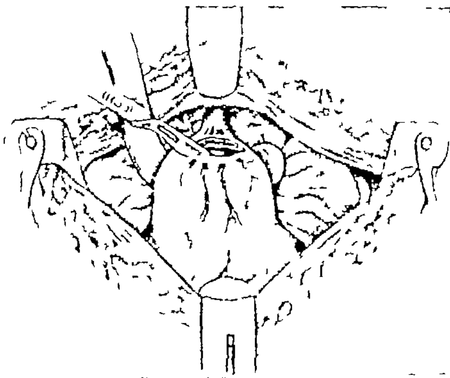


Fig 1050 —Radical retropubic prostatectomy

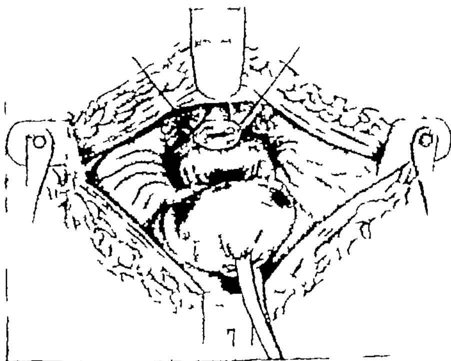


Fig 1051 —Radical retropubic prostatectomy Holding sutures support the cuff at the apex. The whole gland is dissected up off the rectum.

little if any of the capsule can be left but when the gland is being removed for a benign condition it is wise to leave a small cuff of capsule and this will not only facilitate subsequent closure but will also diminish the risk of incontinence and stricture (Fig 1050) The incision in the capsule is deepened to expose the catheter in the urethra and carried through the posterior layer This may be safely done over a curved spatula. The lower free end of the prostate is seized in forceps lifted up and dissected off the rectum as far as the vesicles Always in malignant disease and sometimes in benign they are in turn

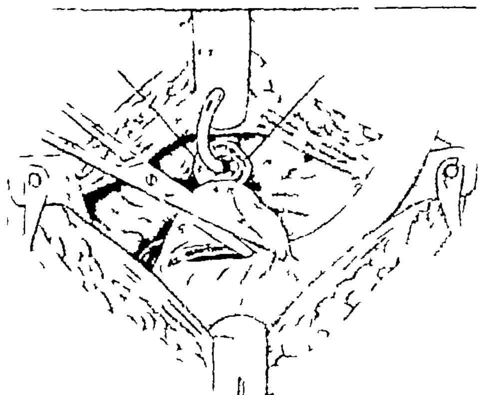


Fig. 1052 —Radical retropubic prostatectomy The bladder is opened at the neck with scissors and the whole prostate with vesicles cut away

exposed and removed. The gland is completely freed by dividing the bladder neck (Fig 1052) All bleeding points are dealt with either with an under running stitch or by coagulation The Tieman s catheter is removed from the urethra and replaced by a 20 or 22 Charriere Foley catheter This seems to us preferable to a Harris which Millin uses since the Foley snugly fits the new bladder neck. The cuff of prostatic capsule with the cut end of the urethra is now united to the bladder neck by a series of interrupted sutures Further inspection is made to see that there is accurate hæmostasis and the wound is closed a corrugated drainage tube being left in

Post-operative care —Bleeding is usually less than after partial prostatectomy for benign enlargement as there is no raw fossa to

allow oozing. The urine rapidly clears and convalescence is usually short. The catheter should always be left in much longer than usual and generally for fourteen days

Treatment of Prostatic Abscess

Since the advent of specific remedies for infections abscess formation in the prostate has become quite rare If the condition is not controlled medically it must be drained. The perineal route is the most satisfactory

Technique.—The patient is placed in the lithotomy position. Preliminary shaving will have been carried out and the perineum and scrotum are now cleaned with a detergent and antiseptic. A 24 Charrière *metal bougie is passed* along the urethra and an inverted V

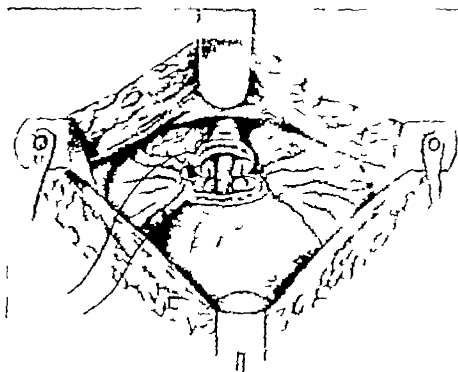


Fig. 1053.—Radical retropubic prostatectomy A catheter is introduced and the cuff of prostatic capsule is joined to the bladder neck.

incision is made starting at the level of the anus on one side passing forwards on the perineum *for 2 cm.* and finishing level with the anus on the other side The fossa on either side of the central tendon is opened up by blunt dissection with a finger and gauze. The central *tendon is put on stretch* and divided and the prostate bulging slightly is felt A sinus forceps is passed into its most prominent part and when opened pus will exude. A corrugated drain is left in.

CHAPTFR XLIII

OPERATIONS ON THE URETHRA

By JOHN EVERIDGE

Revised by HENRY K VERNON

Intra-urethral operations by endoscopic methods.—Examination of and minor operations upon the urethra are carried out by means of the urethroscope. The variety of instruments is wide and since they are used for examination rather than for operative technique require little more than mention Several urethroscopes have how ever been adapted to the performance of minor operations on lesions in both the anterior and the posterior urethra.

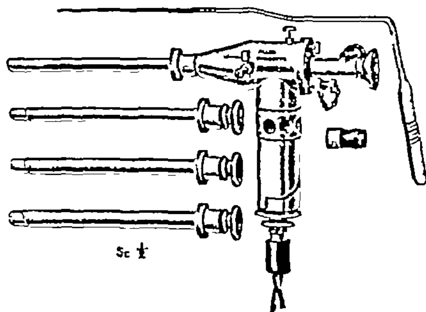


Fig 1054.—Swift Joly s anterior urethroscope.

The anterior urethra—The aero-urethroscope (Fig 1054) des by J Swift Joly* provides facilities for visual examination and it operative attachment simplifies treatment of many of the m r affections to which this section of the urethra is liable Thus nfl follicles and lacunæ can be touched with the silver nitrate-coate probe or the cautery the face of narrow or tortuous strictures be inspected and fine instruments passed and impacted calculi foreign bodies grasped with suitable forceps and removed. It must remembered that incision of abscesses under air inflation is dange from the possible complication of air embolus and the examin must be abandoned forthwith if any bleeding occurs scopy The diathermy coagulating current has supplanted the knife

* Lancet, Jan. 1914, i, 114

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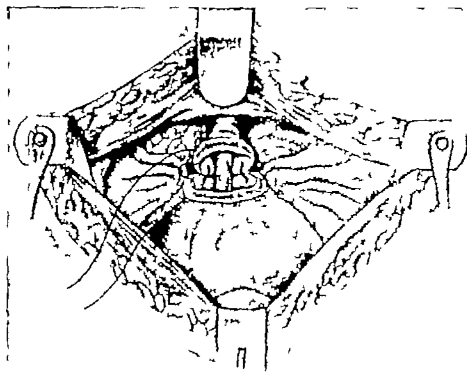


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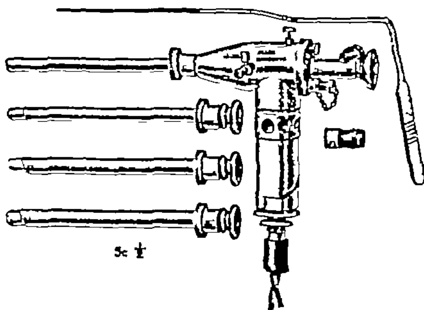


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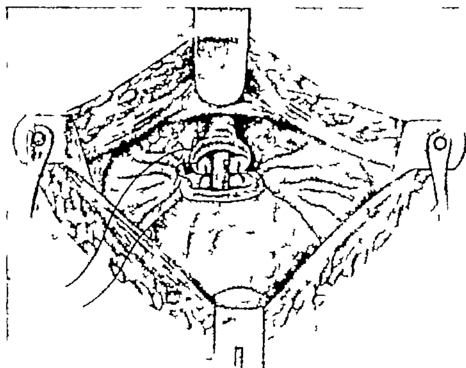


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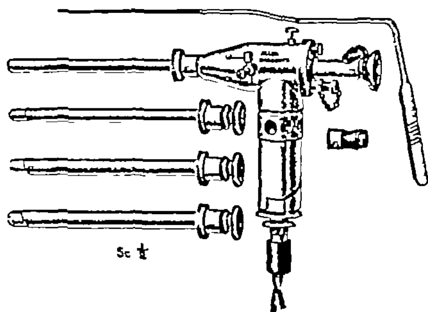


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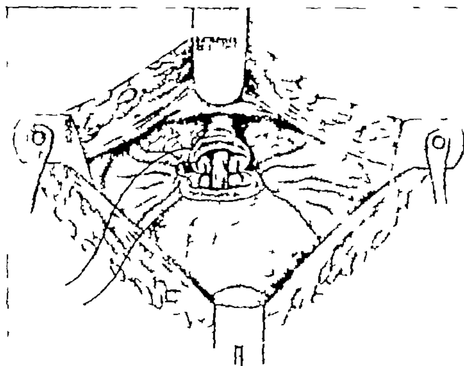


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the posterior urethral tube which fits the syringe is passed and novocaine or xylocaine solution is instilled into the deep urethra (The orifice of the rubber nozzle also fits a ureteric catheter and so this syringe may be used for washing through such catheters This syringe may also be used for displacing a clot in a urethral catheter)

REMOVAL OF CALCULI FROM THE URETHRA

A calculus recently impacted in the **anterior** urethra where no stricture is present may be extracted by snares fine alligator forceps or some improvised hook made from a probe If there is difficulty in passing the external meatus meatotomy is carried out

Where the calculus has been present in the urethra for some time it almost invariably lies behind a stricture or in a diverticulum and a perineal fistula is frequently present also It is sometimes possible when dilating the stricture to push the stone back into the bladder and then remove it with a Bigelow s evacuator If this fails or dilatation is insufficient to allow the stone to pass naturally or be extracted it must be removed by open incision

The perineum is prepared and a staff passed into the urethra. When a large calculus is present the staff will not pass and if a narrow stricture is present the attempt need not be made

The patient is placed in the lithotomy position and an incision is made in the middle line over the calculus which can be felt from the surface If a fistula is present this is dissected down to the urethra, and the urethra opened The calculus is grasped with small lithotomy forceps and removed without difficulty if it is loose and of moderate size Sometimes however it is adherent to the urethral wall and the mucous membrane must be peeled off it. If a stricture is present an instrument can now be passed from the external meatus through it and using it as a guide the incision is extended forwards to sever the fibrous ring If an operation of this nature is carried out in the neighbourhood of the bulb a perineal drainage-tube is passed into the bladder from the posterior end of the perineal wound and retained for a few days

From the prostate and prostatic urethra.—A calculus may lie in the lumen of the prostatic urethra. In old-standing cases additional deposits may have been added so that it comes to project into the bladder through the vesical sphincter and a mushroom calculus is formed. A calculus may also lie in a pocket communicating with the prostatic urethra it projects partly into the lumen of the urethra.

True prostatic calculi are buried in the substance of the gland, and are usually grouped in closed cavities Prostatic calculi may be removed by the suprapubic route An exception is made where the calculus is recently impacted in the prostatic urethra or where it is small and freely movable In these cases large steel sounds are passed and the surgeon endeavours to push the calculus back into the bladder If this is accomplished either the calculus is removed

The posterior urethra —Space does not permit a detailed description of the many complicated instruments available The majority of posterior urethroscopes employ an *irrigation system to facilitate* separation and examination of the walls of the urethra. Blood and débris are washed away by the flow and the whole length of the floor of the prostatic urethra may be examined without difficulty Many of the posterior urethroscopes are adapted for conducting a catheter or electrode with the aid of which a ruptured prostatic abscess may be irrigated with antiseptics through the opening in the urethral wall or its opening enlarged by the high frequency cautery to establish better drainage

The diathermy current permits cauterization of papillomata and polypi electro-coagulation of the hypertrophied verumontanum and resection of obstructive prostatic projections or fibrous tissue. Some operators have catheterized the ejaculatory ducts and irrigated the seminal vesicles with colloidal silver or other antiseptics in cases of obstinate vesiculitis

Among the posterior urethroscopes combining the essentials of good visualization with adjustments for performing the operations referred

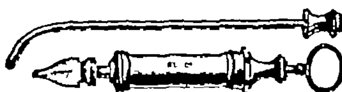


Fig. 1055.—Syringe for urethral anæsthesia (Everidge)

to three have been found reliable namely the posterior urethroscope of Buerger * the cysto-urethroscope of Wolff and the cysto-urethroscope of McCarthy † now known as the panendoscope (see Fig 1018 p 2386) All *these derive their source of illumination* from a distally placed lamp In the first two the optical system supplies indirect observation similar to that in use with the Nitze type of cystoscope The panendoscope is now equipped with a fore-oblique telescope which focuses at an oblique (25 degrees) angle thus more nearly corresponding to direct than to indirect observation the instrument is therefore suitable for a study of the bladder neck as well as for the trigone and the posterior urethra. Further advantages of this instrument are the very efficient system of irrigation and the ease of passing and precise control of large calibre accessories coagulating electrodes the Collings s knife and ureteral dilators for the bladder base is within easy visual range. The prostatic resectotome of McCarthy is an elaboration of the panendoscope (see pp 2386 2387)

If *anæsthesia is required the syringe* shown in Fig 1055 can be used to introduce fluid first into the anterior urethra. The fluid is then massaged through the compressor urethræ and, after 3 minutes

* Journ. Urol., 1911 vol. xxv
† Ibid., 1923, x, 519.

the posterior urethral tube which fits the syringe is passed and novocaine or xylocaine solution is instilled into the deep urethra (The orifice of the rubber nozzle also fits a ureteric catheter and so this syringe may be used for washing through such catheters This syringe may also be used for displacing a clot in a urethral catheter)

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by means of an aspirating bulb and cannula or if it is too large to pass the cannula it is crushed and removed A small recently impacted calculus may pass out with the stream of urine after a catheter has been tied in the urethra for one or two days

When a calculus is too large or is fixed or when it lies in a pocket or is buried in the substance of the prostate gland suprapubic removal of the whole gland is the best method using a curved pair of scissors to dissect the prostate for digital enucleation is seldom possible. The proximal urethra has a tendency to contraction in these cases and subsequent dilatations at intervals may be necessary

If a mushroom calculus is present it is removed suprapubically by traction on the vesical portion. If the calculus is contained in the



Fig 1056.—Lithotomy scoop.

expanded prostatic urethra, the posterior lip of the internal meatus is freely incised in the middle line and the calculus extracted by lithotomy forceps or scoop (Fig 1056)

OPERATIONS FOR STRICTURE

The majority of strictures of the urethra are cured or relieved by the regular passage of dilators but in certain cases a cutting operation becomes necessary

Indications for urethrotomy —

1 Cases unsuitable for gradual dilatation
- (1) Impassable stricture or stricture so narrow that only a filiform bougie will pass
- (2) Cases complicated by urethral calculus peri urethral abscess urethral fistula extravasation of urine.
- (3) Certain diseases of the prostate or bladder complicated by stricture where immediate endoscopic manipulations are necessary Such are enlarged prostate stone tuberculosis new growths chronic cystitis.
- (4) Some diseases of the kidneys complicating stricture (pyelitis and pyelonephritis) (see p 2281)

2 Gradual dilatation has been tried and proved inadequate.
- (1) Dense fibrous stricture
- (2) Resilient stricture
- (3) Where stricture is intolerant of dilatation as shown by the skilled passage of instruments being followed on each occasion by rigors hæmorrhage retention of urine or epididymitis
- (4) Peri-urethral abscess or extravasation of urine complicating the passage of instruments.

3 The stricture is suitable for dilatation but the patient is unable or unwilling to carry out the treatment.

Internal Urethrotomy

The operation consists in cutting through the stricture by a guarded knife (urethrotome) introduced along the urethra. The stricture may be cut from before backwards that is towards the bladder or from behind forwards It may be cut on the roof or on the floor The usual method is to cut from before backwards on the roof of the canal

There are many varieties of urethrotome Thomson Walker s is a modification of Maisonneuve s (Fig 1057) It consists of a fine curved metal staff which has a deep groove on the concave surface extending from the proximal end to just beyond the commencement of the curve. At the point of the staff is a male screw on which a small bulbous tip fits This tip may be removed and a fine flexible guide (4 F) screwed on to the end of the staff by means of a metal end with a female screw This metal end is tapered and projects a short distance inside the flexible guide which thus expands gradually to the thickness of the staff A triangular knife is fixed at one end of a fine

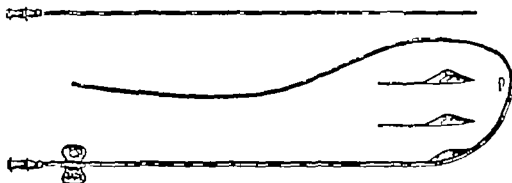


Fig 1057 —Thomson Walker s urethrotome

steel rod the other end of which terminates in a metal button on which is the number representing the size in French gauge to which the knife cuts. The apex of the triangular knife is blunt smooth and broad so that it can glide along the mucous membrane without cutting it. The anterior and posterior edges of the triangle are sharp A small flange on each side of the base of the triangle runs under the lips of the deep groove in the staff and prevents the knife from slipping up Two large flat transverse wings are fixed on each side near the proximal end of the staff and provide a good grip for the fingers and thumb of the assistant. A steel rod which fits into the groove in the staff serves to stiffen it during the introduction of the instrument and is useful in cleaning the groove The rod is removed for the insertion of the knife.

This urethrotome cuts from before backwards Civiale s has a concealed knife which can be projected by a screw in the handle is passed through the stricture and cuts from behind forwards It is rarely used at the present time and is only suitable for strictures of large calibre

Technique.—A general or low spinal anæsthetic may be used but where these are undesirable local anæsthesia by instilling novocain

solution (5 per cent.) into the urethra and retaining it for five minutes, suffices

The parts are prepared by shaving and washing with antiseptic. The urethra is thoroughly washed out with oxycyanide-of mercury solution (1 10 000) from a douche-can with a urethral nozzle.

The surgeon stands to the right of the patient The filiform guide is introduced through the stricture the fine staff screwed on to the guide and the instrument well oiled, is pushed onwards If the calibre of the stricture will admit a No 8 F bougie the filiform guide may be dispensed with the small bulbous end screwed on the tip of the staff and the instrument passed through the stricture The staff lies with



Fig 1058 —Internal urethrotomy Hands of assistant holding wings of urethrotome surgeon steadying penis and pushing triangular knife along guide.

the curve in the membranous and prostatic segments of the urethra the flexible guide coiling inside the bladder

The staff is held by an assistant at an angle of 45° *He leans well* over the patient and places one elbow on each of the patient s iliac crests and grasps the staff with the thumb on the upper surface of each wing holding the instrument absolutely steady in the middle line.

The surgeon dips the point of the triangular knife in sterile oil and introduces it into the groove of the staff The glans penis being raised with the left fingers and thumb the knife is slipped past the meatus and with the button held at the end of the rod is pushed steadily along the urethra until the resistance of the stricture is felt (Fig 1058) A sharp push cuts the stricture and the knife slips on and cuts any others that may be present. The knife is now steadily withdrawn until the resistance of the stricture is again felt and a tug at the rod cuts through with the sharp reverse edge of the knife.

Unless the knife be boldly pushed through the stricture the fibrous tissue will not be cut The knife rod is withdrawn altogether and the staff and guide are removed

A steel sound of 12–14 size is now passed followed by 13–15 and 14–16 If resistance to the passage of the instrument is felt the urethrotome should again be passed this time with the bulbous end in place of the filiform bougie and the knife again run through the stricture If the meatus is too narrow to admit a large steel instrument it should be slit downwards A coudé catheter (22 F) is passed into the bladder and the urine drawn off If the urine is foul the bladder should be washed with a weak solution of oxycyanide of mercury or a solution of nitrate of silver (1 10 000) The catheter is withdrawn until the eye lies just within the bladder and is tied in A roll of gauze is placed around the catheter at the external meatus and is held in position by the tapes that secure the catheter A syringeful of fluid is injected to ascertain that the catheter eye is in the bladder a plug is inserted into the end of the instrument and the patient returned to bed

After treatment —The urine is drawn off at frequent intervals by removing the plug from the catheter or a piece of rubber tubing may be attached and the bladder drained continuously into a urinal At the end of forty-eight hours the catheter is removed and the urethra may be washed with an antiseptic lotion The object of the retained catheter is to prevent the wound in the urethra from becoming soiled with the urine which is usually infected There is less frequently a rise of temperature during the first twenty four hours after the operation when a catheter is retained than when it is omitted

After removal of the catheter the patient is kept quiet in bed for a week and then allowed up A daily irrigation of the urethra may be given if the urine is infected. No instruments are passed for fourteen days after the operation and then a full-sized metal sound (14–16) is introduced This is repeated in a fortnight and if the surgeon is satisfied that no contraction is taking place the intervals between the passage of instruments are increased to three weeks four weeks six weeks two months three months four months six months finally a year s interval is allowed and if no contraction has then taken place and the urethroscope shows no narrowing the patient is pronounced cured

Difficulties and dangers.—(1) The fine guide of the urethrotome may break across at the junction with the metal base which unites it to the staff and on withdrawal of the instrument it is left in the bladder If this accident happens another guide should be used and the operation proceeded with With the calibre of the urethra adequately enlarged the first guide can be removed by a lithotrite preferably of the type with cystoscopic attachment or by Young s cystoscopic rongeur This accident is less likely to happen if after screwing the staff into the guide traction is made on the junction to make certain this is secure

(2) After the removal of the urethrotome the surgeon may fail to pass a metal sound. The difficulty may be due to imperfect cutting of the stricture by a blunt knife or to a want of boldness in the cutting stroke The guide of the urethrotome should be replaced by the small bulbous metal tip, the staff re-introduced and the stricture cut to the full size. Should the surgeon fail to re-introduce the urethrotome staff a Harrison whip bougie will be the most likely instrument to pass, and this may be followed by the urethrotome staff or by large metal sounds

(3) At the operation and for the succeeding few days bleeding is usually negligible Serious hæmorrhage may however occur and a few fatal cases have been recorded It is most likely when the urine is septic. And in such cases post-operative sulphatherapy and streptomycin if the organisms are susceptible are invaluable.

When bleeding takes place the foot of the bed should be raised an ice-bag containing finely crushed ice should be placed on the perineum, and firm pressure applied by a large sand bag Sand bags or other support should be so arranged as to prevent the shoulders of the patient from slipping towards the head of the bed. If a catheter is already in the urethra it should be allowed to remain as it will assist the pressure and allow the escape of the urine If the catheter has already been removed then a large 22 or 24 F gum-elastic catheter is passed and a firm perineal T bandage effects pressure in the perineum. Without it bleeding tends to recur on micturition. A hypodermic injection of morphia should be given and hæmostatic serum or other hæmostatic agents injected. Should these measures fail, the catheter should be removed the urethra irrigated with hot solution of silver nitrate (1 10 000) and pressure re applied. Finally should the hæmorrhage resist all treatment perineal section should be rapidly performed and a large-sized perineal tube introduced into the bladder Iodoform gauze is firmly packed around this tube or into that part of the urethra from which blood is escaping Blood transfusion may be necessary

Late complications. (1) **Urethral fever**—A retained catheter in the urethra for forty-eight hours prevents urethral fever and enables the surgeon to wash the bladder in septic cases Occasionally the temperature rises after the catheter has been removed. If so the urethra should be irrigated with a weak solution of silver nitrate (1 20 000) should the temperature not subside the catheter is re-introduced, retained for several days and the bladder thoroughly washed.

(2) **Infection and anuria.**—These are rare unless there has been chronic retention with renal back pressure or pre-existing infection of the kidney but cases occur where death takes place within forty-eight hours without obvious signs of pre-existing renal involvement.

Where advanced renal disease (ascending pyelonephritis) is present the case is unsuitable for immediate internal urethrotomy rapid

cystotomy either suprapubic or perineal should be performed and the cure of the stricture left to a later date

Where a high temperature with anuria has supervened one kidney may be painful and tender or enlarged on palpation In such cases a rapid nephrostomy may be needed. In the absence of signs of focal renal infection, treatment should aim at re-establishing renal function by intravenous saline or glucose (5 per cent. solution) and diuretics

Where the operation is performed in cases complicated by urinary infection and especially in subjects liable to rigors after instrumentation administration of sulphacetamide or chloromycetin commenced 24 hours before operation and continued afterwards is a wise precaution to be taken

Mortality—In all cases of stricture the mortality depends more on the condition of the kidneys than on the local condition The mortality of internal urethrotomy is small In 4 656 cases collected from the literature (nine observers) the mortality was 0 49 per cent Watson and Cunningham (Diseases and Surgery of the Genito-Urinary System 1909) collected the published results of a number of surgeons some of which are included in the above results. In a total of 4 686 operations there were 53 deaths a mortality of 1 1 per cent At St Peter s Hospital during a period of twenty-nine years (1895 to 1928) internal urethrotomy was performed on 2 088 patients of whom 27 died after the operation giving a mortality of 1 29 per cent This remains at the present day a fair statement of the risk incurred.

After-results.—The results obtained vary with the character of the stricture. In a well-defined annular stricture in a healthy subject internal urethrotomy will result in a complete cure in a few cases In a larger number there is recontraction of the stricture after a few months or several years but the passage of a large metal sound at intervals is usually sufficient to prevent this Irregular attendance alcoholic indulgence and other causes frequently produce relapses so that the cutting operation may have to be repeated and the dilatation resumed

The final group is that of dense fibrous stricture where there is no prospect of cure by urethrotomy or dilatation.

External Urethrotomy

The operation of external urethrotomy consists in cutting a stricture by an incision made as a rule through the perineum occasionally through the floor of the pendulous urethra. The operation takes longer to perform and the convalescence is more protracted than in internal urethrotomy It is therefore reserved for cases where some complication is present which contra indicates internal urethrotomy e.g impassable stricture with acute retention.

External urethrotomy with a guide (Syme's operation)—This operation* consists in the passage of a Syme s staff through the stricture

* Edin. Journ. Med. Sci., Oct. 1844 iv 817

incising the urethra upon this immediately behind the stricture and then cutting forwards through the stricture

The operation has now been superseded by internal urethrotomy because if it is possible to pass a Syme s staff it is possible to pass a guide and carry out internal urethrotomy



Fig 1059 —Syme s staff.

External urethrotomy without a guide (Wheelhouse's operation).*— When the surgeon has failed to pass an instrument through the stricture the urethra may be opened in front of the stricture and the narrow aperture sought A fine probe is then passed through, and the stricture slit up on it This operation was first performed in 1822 Wheelhouse slightly modified the technique and it has been known by his name ever since. Wheelhouse s staff is a straight instrument with a groove which stops short about ¼ in from the end. The rounded end forms a small projection like the end of a crochet hook on the side opposite the groove (Fig 1060)

The patient having been prepared for a perineal operation the staff is passed down to the face of the stricture with the groove towards the skin An incision is made in the middle line of the perineum which opens the urethra on the groove of the staff The urethra is incised upwards towards the penis for about 2 in.



Fig. 1060.—Wheelhouse s staff.

As the groove does not reach the end of the staff the incision is not carried up to the face of the stricture and the relation of the stricture to the rest of the urethra is preserved The staff is now turned round and withdrawn so that the projection at the end hooks up the upper angle of the wound. The mucous membrane of the urethra is picked up on each side and retracted with a fine thread

With a good head-light the surgeon searches for the opening of the stricture using a fine probe or a grooved director for the purpose (Fig 1061) The thumb of the left hand is placed in the lower angle of the wound and the stricture slightly everted by the fingers pressing on the perineum behind it. Every dark spot is carefully probed and searched. The chief difficulty of the operation is the oozing which obscures the field with blood and for this reason it is wise not to

* Brit. Med. Journ., 1876, i, 779.

commence a Wheelhouse operation at the end of a prolonged attempt to pass instruments through the stricture

When the blood is trickling down from the upper part of the wound a small plug of wool or gauze tucked in beneath the staff may control the hæmorrhage But the mucous membrane is often congested and friable and the oozing comes from the whole surface

A plug soaked in adrenaline may greatly assist by stopping the oozing If the opening is not found in what appears to be the face of the stricture the roof of the urethra should be searched in front of it

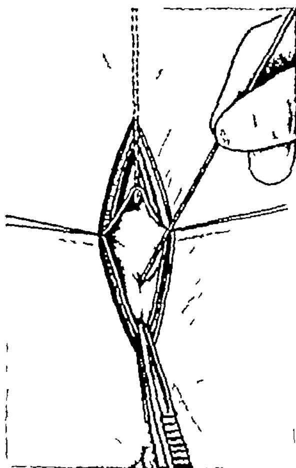


Fig 1061 —Wheelhouse's operation for urethral stricture.

The openings of the lacunæ on the roof are often deceptive. Pressure on the bladder may cause the escape of a few drops of urine and disclose the position of the stricture-lumen. Methylene-blue may be injected into the urethra before the operation so that it permeates the stricture and stains the track

The opening of the urethra having been found a probe is passed through the stricture and on this a director the point of the knife follows this guide and cuts freely through the floor of the stricture. The urethra behind the stricture is usually dilated and a larger director

or gorget is readily passed into the bladder A large catheter is now passed along the penile urethra and is guided into the bladder by the gorget but in cases where the urine is heavily infected it is probably wiser to drain the bladder by a perineal tube for a few days. The perineal wound may be left open or one or two catgut sutures inserted to draw the edges of the urethra and the perineal tissues together The catheter is retained in place for four days and then removed. Some urine will probably escape from the wound after removal of the catheter but this rapidly ceases and in a few days the wound is dry The passage of steel sounds is commenced fourteen days after the operation

If Wheelhouse s operation fails one of four procedures may be adopted

1 **Dissection.**—The urethra may be exposed by dissection behind the stricture and here opened This is done by prolonging the incision backwards towards the anus or if the first median incision is far forward by making a second incision in front of the anus over the posterior extremity of the bulb or a curved prerectal incision may be made so as to give a free exposure for careful dissection. In practice the last is seldom necessary The bulb is first exposed and when the posterior extremity of this is reached the urethra is easily exposed since it is considerably dilated at this part A probe is passed distally through the stricture and the scar tissue slit up from behind forwards upon this A gorget or director is passed into the bladder and serves as a guide for a catheter passed along the penile urethra and thence into the bladder

2. The second method which has been practised in this dilemma is **Cock s operation** of perineal section without a guide.* It was used as a means of draining the bladder in acute retention by incising the dilated urethra and intubating the bladder through this approach. Suprapubic cystotomy has rendered this operation obsolete.

3 **Retrograde catheterization after suprapubic cystotomy**—In the cases where this procedure is required the bladder is usually distended with urine so that it is easily exposed and opened. A fully curved metal catheter (Béniqué) is passed along the urethra from behind forwards It is made prominent in the perineum behind the stricture and the point cut down upon in the middle line of the perineum An attempt can now be made to pass a probe forwards through the stricture so that this may be cut from behind forwards. If the probe cannot be passed through the stricture a sound should be passed down to the front of the stricture and the cicatricial tissue cut through in the middle line until this is exposed. The bladder is drained either through a perineal tube through a catheter tied in the urethra, or suprapubically the last being the method most generally adopted. This method should only be used as a last resource because the urine

* Guy's Hosp. Repts. 1866, 3s, xii, 267

is generally heavily infected and the cystotomy is performed without being able to wash out the bladder by way of preparation

4 **Loughnane*** cuts down on a sound in the anterior urethra and withdraws it with a 22 F rubber tube threaded over its tip thus implanting the tube in the anterior urethra from the perineal wound to the external meatus He then passes a sound retrograde from the suprapubic opening and cuts down on its tip in the perineum. He now withdraws it with the perineal end of the rubber tube threaded upon it This tube now passes continuously from the external meatus through the suprapubic opening No notice is taken of the constricted portion of the urethra. The tube is fixed with a safety pin at either end and if the perineal wound is septic it is packed and allowed to granulate The tube is rocked to and fro daily and changed weekly till a 30 F calibre is reached. Sounds are passed intermittently after removal of the tube.

Dangers of external urethrotomy—The dangers are due (*a*) directly to the operation or (*b*) to exacerbation of pre-existing disease.

(*a*) **Hæmorrhage**—Severe hæmorrhage may occur either from the spongy tissue of the corpus spongiosum or from some vessel deeper in the perineum or at the neck of the bladder It may supervene within a few hours of the operation or not until eight or ten days later

When hæmorrhage occurs the patient should be put up in the lithotomy position the wound opened up and after turning out the clots a search made for the source. A stream of hot lotion from an irrigator and a good head light will greatly assist the search Any bleeding vessel should be picked up If a perineal tube is already in the bladder strips of gauze should be packed around it If a tube has not been tied in it should now be passed with the help of a gorget and the wound packed around it A broad T bandage allowing for the exit of the tube provides firm pressure on the perineum

(*b*) The majority of patients requiring external urethrotomy for stricture are poor subjects for operation Urinary sepsis is present and this combined with obstruction and back pressure has damaged the kidneys Chronic bronchitis and emphysema arteriosclerosis and chronic constipation are often present and very readily lead from the circumstances necessitating the external urethrotomy or from the effect of the operation itself to fatal complications

After-treatment.—The catheter or the perineal tube should be removed on the fourth day and the urine will for some days drain through the perineal wound

The bladder is washed daily through the catheter suprapubic or perineal tube and when this is removed the wound and the bladder are irrigated by hydrostatic pressure the glass nozzle of an irrigator being applied to the perineal wound. Silver nitrate solution (1 15 000) boric acid solution or oxycyanide-of mercury solution (1 10 000) may

* *Brit. Journ. Urol.*, 1941 xiii, 109.

be used for this purpose. Once urinary drainage is secured after the operation sulphatherapy and antibiotic therapy are given.

As soon as possible after the tube is removed the patient should sit for an hour or more daily in a hot hip-bath to which permanganate of potash or boric acid crystals have been added. Steel sounds are passed on the fourteenth day and at pre-arranged intervals afterwards

Results.—External urethrotomy is reserved for the most serious and complicated cases of stricture and the mortality is therefore high. It cannot be fairly compared with the mortality of internal urethrotomy which is employed for milder cases and as a rule those not complicated by acute retention.

Grégoire* collected 992 cases with a mortality of 8·8 per cent Thompson† published 219 cases with 6 5 per cent and Horwitz‡ 116 cases with 4 8 per cent. mortality

At St. Peter s Hospital during a period of twenty nine years (1895–1928) external urethrotomy or perineal section was performed in 185 cases with 11 deaths a mortality of 5 94 per cent

In all cases of stricture the prognosis for life depends much more upon the functional state of the kidneys than upon the local condition.

There is no greater certainty of curing a stricture by means of external urethrotomy than by other methods Where instruments are passed regularly after the operation cases in which no recontraction is found are not infrequent. Where the patients neglect regular dilatation and exposure and alcoholic excess are superadded recontraction of the stricture is almost certain and it will become hard and cartilaginous There are cases however in which notwithstanding regular habits and periodic instrumentation the stricture slowly contracts after the operation and a second cutting is required. In 100 cases of stricture attending the clinic of Sir J Thomson Walker at St Peter s Hospital external urethrotomy had been performed in 12. In 5 of these it had been performed once in 2 twice in 1 five times in 1 six times In 8 cases external urethrotomy was followed by internal urethrotomy at a later date In more recent years however the operation is much less frequently required.

Excision of Stricture

A single stricture may be resected but multiple strictures are unsuitable for excision. Traumatic stricture is solitary and usually short and the remainder of the urethral mucous membrane is normal. There is much peri urethral fibrous tissue the removal of which is essential for its cure This form of stricture is therefore best suited for excision.

Technique.—1 The suprapubic and perineal regions are prepared for operation Suprapubic cystotomy is performed. The patient is placed in the lithotomy position and a metal instrument is passed

* *Thèse de Paris*, 1879. † *Stricture of the Urethra*, 1885.
‡ *Journ. Cutan. and Gen.-Urin. Dis* 1898, xvi, 202.

through the stricture There is no difficulty in doing this as the excision of a stricture is not an emergency operation in an impassable stricture but one planned carefully on a stricture in which dilatation and other measures have failed after prolonged trial A median incision is made for 2 or 2½ in with the strictured area as the centre. The corpus spongiosum is exposed and its sheath incised to the full extent of the wound. Careful dissection defines the hard fibrous tissue of the stricture Where there is extensive peri urethral scarring it may be separated from the surrounding structure as a thick ring of yellowish white almost cartilage-like tissue This is detached from the whole circumference of the urethra. The floor of the urethra is incised longitudinally on the metal instrument and the stricture-ring cut About 1½ in. of urethra with the stricture as the centre is thus laid open longitudinally The metal instrument is now removed The hardened tissues forming the stricture are defined and the urethra is cut across transversely through supple mucous membrane and sub-mucous tissue in front of and behind the fibrous area.

The approximation of these ends is the next step When the gap is narrow the detachment of the urethra already carried out will allow this without tension. But when the gap is considerable further dissection is necessary Approximation is obtained by mobilizing the corpus spongiosum and not by dissecting the urethra out of its sur rounding erectile tissue The corpus spongiosum should be detached from the corpora cavernosa in front of and behind the area of excision until the cut ends of the urethra are easily brought together (The extent to which this may be done will be discussed later) The ends of the urethra are now united Each end has been slit up on the floor for ¾ to 1 in. and the urethral tube laid open With fine No 8/0 catgut sutures the edges of the cut ends are carefully united. These sutures include the whole thickness of the urethral wall If the corpus spongiosum has been mobilized one or two stitches are introduced into the sheath so as to hold it and prevent tension and anchoring sutures passed through the corpus spongiosum and then through the ischio-cavernosus muscle laterally are useful to hold the ends in apposition and take tension off the anastomosis.

The longitudinal incision in the urethra is carefully sutured so as to re-form the urethral tube For this purpose a catheter is passed along the urethra, and the edges are brought together over this by a series of interrupted fine catgut sutures Over this again the sheath of the corpus spongiosum is sutured and the layers of the perineum are approximated by catgut sutures and the skin wound loosely drawn together by silkworm gut stitches a drain being placed in an angle of the wound for twenty four hours to prevent the formation of a hæmatoma. The catheter is then removed The cystotomy opening is sutured about a Malécot tube

2 A second method has been recommended by Hamilton Russell.* One of us (J E) prefers this operation the steps are recognizable

* Brit. Journ. Surg 1915, ii, 375.

in Figs. 1062 1063 1064 An inverted V incision is made with the apex of the V at the central point of the perineum The ischio-rectal fossa is opened up on each side and the membranous urethra and apex of the prostate are if necessary exposed as in perineal prostatectomy

In many cases it is an advantage to establish and maintain supra pubic drainage for a fortnight. If the bladder has been opened, use

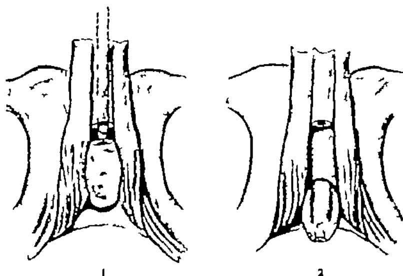


Fig. 1062.—Stages in excision of stricture (Hamilton Russell s method)

(*Modified from British Journal of Surgery*).

1 The urethral staff defines anterior face of stricture and a transverse section is made. 2, The fibrotic mass is separated on all sides, elevated, and dissected backwards until healthy urethra is encountered. A retrograde catheter (not shown) facilitates discovery of healthy urethra on the bladder side of the stricture, if necessary

may thus be made for retrograde passage of a Béniqué catheter by which the membranous urethra and the urethra behind the stricture are disclosed.

The next stage is the exposure and opening of the urethra in front of the stricture. A median incision is made from the apex of the V for wards A Wheelhouse staff is passed and the urethra opened, and the margins are retracted by silk thread stitches (Fig 1062.) The urethra is slit back to the stricture The strictured portion of the urethra with fibrous extra urethral mass is excised, the cut ends are freed by undercutting and their ventral walls incised longitudinally for one inch. The loose ends are brought together by fine interrupted catgut sutures which unite the roof only (Fig 1064)

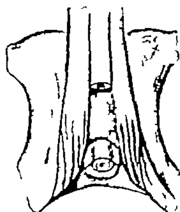


Fig 1063 —Transverse division posterior to the stricture.

A rubber catheter is passed into the bladder through the perineum at the posterior extremity of the incision and fastened. (Fig 1064.) The two lateral incisions in the perineum are sutured No sutures are

placed in the perineum in front of the catheter and the longitudinal wound in the urethra is left unsutured The catheter remains in for a week and after its removal the perineal wound is allowed to heal by granulation

The condition obtained here after operation is exactly that which exists after external urethrotomy and healing in both cases takes place rapidly without the production of scar tissue from the longitudinal incision in the urethral wall Care should be taken that the oozing from the corpus spongiosum and any other bleeding is arrested

Three points in excision of stricture are open to discussion

1 *Drainage of the bladder*—Many authorities recommend a retained catheter in the urethra and do not drain the bladder suprapubically We are strongly of the opinion that in order to obtain a reasonable certainty of success in many plastic operations upon the urethra

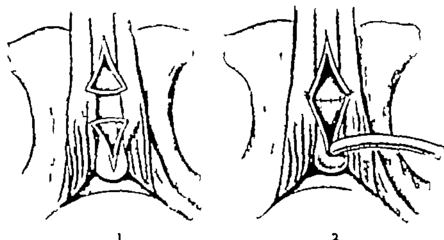


Fig 1064.—1 The urethral ends are mobilized by separation on all sides and their floors incised longitudinally 2 Apposition by suturing reconstructs the urethral roof as a riband the floor and sides are not sutured. A tube is passed into the bladder and stitched in position.

suprapubic drainage must be used. The retained catheter produces urethritis and also allows a certain amount of urine to trickle alongside it and soak the line of incision Hamilton Russell drained by a catheter in the posterior angle of the urethral incision which was left freely open as a safeguard against extravasation of urine

2 *Suture material*—Sutures of fine chromicized catgut size 8/0 are suitable for this work The fine catgut is absorbed or comes away in the urine

3 *Extent of tissue removed*—It is recommended by some surgeons that only a part of the circumference of the urethra be removed and a strip of the roof left to maintain the continuity Guyon and Albarran* recommended this method which prevented retraction of the severed ends of the urethra. They argued further that the roof in traumatic stricture might escape injury and that healing in partial resection was more rapid Experience has not upheld any of these arguments.

* "Médecine Opératoire des Voies Urinaires," 1909, p. 923.

With a full incision and free mobilization of the corpus spongiosum there is no difficulty from retraction

An inch to an inch and a half of the urethral wall in its entire circumference may be removed and if the mobilization of the corpus spongiosum is freely carried out there will be no difficulty in approximating the ends without tension *especially if the legs are lowered when the sutures are being tied* Where the stricture lies far back close to the membranous urethra the difficulty is greater for only the anterior end of the urethra can be drawn upon. As much as 6 cm (2½ in.) (Burckhardt * and even 8 cm. (3 in.) (Goldman †) has been resected with success

After-treatment.—Suprapubic drainage is continued for fourteen days, and the tubes are then removed.

A fortnight after the operation steel instruments are gently passed Hamilton Russell however did not consider this necessary until after the lapse of several months

Results.—The cases collected by Nogués and Vignard (quoted by Huesco) *Comptes Rendus XIII Congrès Internat de Med* 1900) show that resection of the stricture in suitable cases is a successful operation and that permanent cure can thus be obtained. In 15 cases there was no recurrence at the end of periods varying from six months to eight years. Most surgeons however would not agree that complete cure was possible.

In 18 cases of resection collected by Watson and Cunningham (*op cit*) in which information was obtained a year or more after the operation there were only *5* in which the urinary stream or the urethral calibre was normal. Hamilton Russell (*vide supra*) reported 8 cases of severe stricture treated by his method. All were successful in that full-sized bougies could easily be passed after the normal intervals.

RUPTURE OF THE URETHRA

The various types of rupture differ widely in their diagnosis treatment and sequelæ according to the situation of the injury

The anterior urethra.—(*a*) The *pendulous* section in front of the suspensory ligament is rarely injured, but a hæmatoma or an abscess following a crush or squeeze may require evacuation (*b*) The *perineal* section from the compressor urethræ to the symphysis pubis is the commonest seat of injury in virtue of its fixation and non-resilient background. The varieties and methods of treatment require more detailed consideration.

(i) Incomplete.—Here the dorsal wall remains as a bridge which limits retraction any of the walls may be contused or the mucous coat lacerated or the whole thickness severed.

(ii) Complete, where there is solution of continuity through all coats

* Frisch u. Zuckerkandl, *Handb. d. Urologie*, 1904, iii, S 96.

† *Beitr z. klin. Chir* 1904, xlii, 230.

in the entire circumference of the urethra with contraction and retraction of the ends

Symptoms and signs vary according to the degree of injury Passage of blood inability to micturate (from compressor spasm) a perineal extravasation of blood or later of urine and hindrance to instrumentation are the outstanding features and these guide the policy of treatment Catheterization is of great value in confirming the diagnosis but it is only permissible to pass an instrument when arrangements for immediate operation have been made. In the mildest cases where there is no perineal swelling and a catheter passes easily all that is necessary is to leave it *in situ* for 24 to 48 hours. Although micturition is thus restored the precursors of stricture exist and warning of the need for future instrumentation is no small part of the surgeon s duty

Where there is perineal swelling an incision into it is advisable even though catheterization can be carried out without difficulty Some surgeons go so far as to say that every case presenting any symptoms of rupture no matter how slight should always be provided with such a safety outlet this being the best prophylactic against stricture (Grey Turner) Where the catheter is checked operation is always indicated for a severe injury is of necessity present requiring not only perineal drainage but often some steps to restore urethral continuity

Technique.—At the operation a mid line incision is carefully deepened great caution being exercised as the urethra, made evident by a rigid instrument is approached The extent of damage is defined. If the rupture is (i) *incomplete* it may be possible to coax the catheter through the proximal end into the bladder and perhaps to repair the urethra by two or three catgut sutures Many surgeons have declared that sutures are unnecessary or even harmful because the gap is only opened out by the lithotomy posture and will close automatically when the legs are extended If the catheter can be made to enter the bladder the perineal tissues are loosely approximated ample room being allowed for suitable drainage In these circumstances the instrument should be left in for a week Many prefer suprapubic drainage as the best means of preventing the escape of urine into the perineal tissues the irritating effect of which is one of the most active agents in stricture formation. Urinary diversion can also be established by inserting a catheter through an incision in the urethra behind the site of the repair Grey Turner* for many years regarded this as the method of choice

If (ii) *a complete rupture* exists the ends may be separated an inch or more and finding the bladder end by a direct search would sacrifice valuable time and patience In such cases an immediate suprapubic incision is made the bladder is opened and a fully curved metal instrument is passed through the internal meatus and along the bladder end of the urethra until it presents in the perineal wound The end of the proximal dorsal wall is thus defined and is supported by catch forceps

* Lancet, 1933, ii, 82.

while through and through catgut sutures which include the corpus spongiosum attach it to the roof of the distal end The side walls are then sutured but before closing the floor the catheter which up till now lay in the penile urethra, is coaxed up into the bladder perhaps aided by attachment of its end in some way or other to the end of the instrument

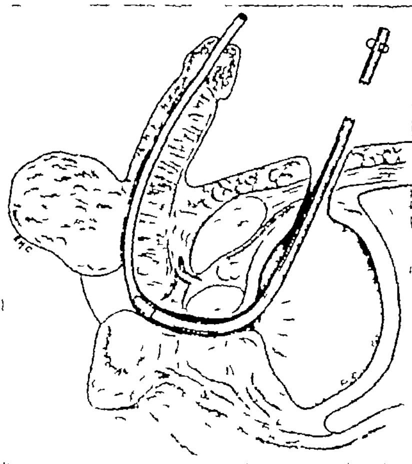


Fig 1065 —Rupture of posterior urethra.

A method of introducing the splint catheter. A curved metal catheter (Bénique) passed in retrograde fashion has been telescoped through the end of a rubber catheter opened by removal of its blind tip. The manipulation to effect this is carried out in the perineal wound.

passed from the bladder (Fig 1066) Rutherford Morison recommended that a mesial linear incision should be made in either torn end of the floor before suture as a means of diminishing the risk of stricture. The catheter is removed at the end of the operation but the suprapubic tube is retained for a fortnight Replacement of the catheter in the third week may be necessary to aid closure of the suprapubic fistula. Three weeks after its withdrawal steel bougies are passed and subsequently at lengthening intervals of time.

The posterior urethra.—Rutherford Morison stated long ago in his Surgical Contributions * that the surgeon called to attend such

* 1918, Vol. I, p. 271

a case was probably presiding at the opening of a life long tragedy Special attention must therefore be drawn to it on account of the vital necessity for appropriate treatment in the early stages Being frequently associated with grave skeletal injuries the state of the urethra may be overlooked fractured pelvis or femora apparently having prior claim to attention The surgeon may content himself with the establishment of suprapubic drainage and indeed this is a necessary and life-saving procedure in all cases but it is essential to realize the frequency of interrupted alignment of the urethra brought about by dislocation of the severed ends from traction of the bone fragments or fascial tension or the pressure of extravasated blood or urine. Mal alignment can only be prevented or corrected by a catheter to act as an internal splint and the earliest opportunity for its emplacement must be seized. A fortnight s catheter residence will usually suffice to fix the urethra and subsequent passage of metal bougies will preserve the line and calibre Suprapubic drainage is always necessary in these cases

The surgeon unless he can find a distended bladder may be in doubt whether he is dealing with a rupture of the deep urethra or of the bladder base His exploratory catheter may mislead by tapping the retropubic space If suprapubic incision shows an empty bladder the injury is vesical with a rupture below the internal sphincter there will probably be some urine in the bladder Suprapubic and prevesical drainage may be all that are justifiable as first aid measures As soon as recovery from the shock of the accident and accompanying injuries allows further interference, the catheter is emplaced either in the whole length of the urethra if possible or from the bladder to the perineum through a retro-scrotal stab In the former case a curved metal catheter of the Béniqué type is passed by way of the cystotomy opening through the deep urethra and is brought out through a transverse incision in the perineum A stiff rubber or gum-elastic catheter is passed from before backwards through the pendulous urethra until it appears in the perineal wound Its bladder end is then either attached by a suture to the metal catheter or the metal catheter is invaginated into the end of a rubber catheter opened to make way for it by removal of its tip (*see* Fig 1065) Thus it is drawn up into the bladder where it will remain A length of silk attached to the point of this catheter *en demeure* serves to suspend it suitably in the bladder the other end of the silk being sutured at the suprapubic opening and this will aid in the subsequent changing of the catheter when necessary

In the latter case where a prolonged anæsthesia would hazard the patient s life the surgeon is tempted to content himself with suprapubic drainage alone The objection is that the urethral ends rapidly become fixed in faulty alignment hence it is wise to retain some control of the bladder end of the urethra by a tube drawn up through a perineal stab This may be rapidly done by passing a pair of long artery forceps downwards through the bladder end of the urethra until the point is

felt to project into the perineum An incision is made over the forceps which are opened to seize the tube thus drawing it up into the bladder It is sutured to the perineal skin At as early a date as possible continuity of the urethra is procured by emplacing a catheter in its whole length The perineal opening is made the centre of a triradiate incision the anterior limb of which passes forwards for 2 in. towards the scrotum and the lateral limbs outwards and backwards.

The tube is removed and a curved catheter is passed from the bladder in retrograde fashion so that it projects through the perineal opening A gum elastic or firm rubber catheter is then passed backwards through the external meatus to the perineal wound and its end is attached to the metal catheter by which it is drawn up into the bladder as in primary catheter emplacement Suturing the torn ends of the urethra may be possible in the early stages after preliminary trimming later they will have become too disintegrated to hold stitches With the aid of the suspending stitch catheters may be changed frequently preferably twice a week the fresh catheter being drawn up by a stitch attached to the distal end of the previous one and this stitch in its turn being fixed to the suprapubic wound in an accessible position to serve for further replacements Splint catheterization should be continued for at least a fortnight.

During the residence of the catheter the bladder should be washed through twice daily with nitrate of silver solutions 1 in 12 000 The suprapubic tube is removed during the third week and the wound allowed to heal. Steel bougies are passed three weeks after removal of the catheter and afterwards at intervals increasing to three months for the first year subsequently at such intervals as are suggested by the rapidity of closure of a stricture.

Sandrey* recommends the following procedure After clearing the space of Retzius a Malecot catheter on an introducer is passed per urethram so that its point can be felt just above the triangular ligament. By means of a finger in the internal urinary meatus the posterior urethra can generally be brought down so that the tip of the catheter enters its lumen. If this manœuvre fails a soft rubber catheter is passed from the internal meatus and its tip withdrawn through the space of Retzius the end of the catheter is cut off and the point of the distal catheter passed into its lumen thus making a junction between the two The distal catheter can then be easily guided into the bladder A rubber washer about 1¼ in. in diameter is then slipped over the head of the Malecot catheter and the introducer withdrawn. A silkworm stitch is passed so as to include the head of the catheter and the washer and secured to the abdominal wall by means of a Harris metal rod. The prevesical space is drained and a suprapubic tube inserted. Continuous urethral traction is maintained for seven days by means of a weight of 1 lb attached to the catheter and suspended over a pulley at the end of the bed. (*See* Fig 1066)

Naunton Morgan describes a planned perineal approach as in

* *Med Press and Circ.*, March, 1943, ccix, No. 5418.

perineal prostatectomy The triangular ligament is detached and turned forwards and a flap fashioned and turned down from the proximal urethra and sutured to the distal ruptured end In most cases however the shock present is too great to allow of a possibly long and tedious repair

Functional results.—The formation of a stricture after rupture of the urethra was almost invariable in cases recorded by the older writers The result was due to sloughing and septic inflammation

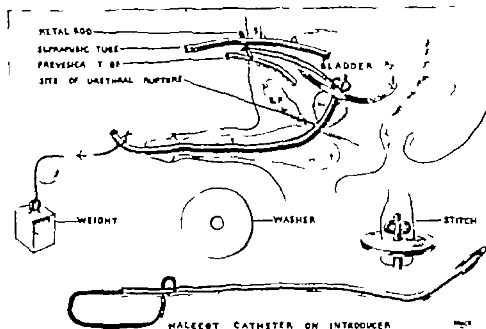


Fig. 1066.—Illustrating method of splinting posterior (membranous) urethra advised by J G Sandrey

When rapid healing of the urethra is obtained the canal either remains uncontracted or the stricture which forms is a simple narrow ring readily amenable to treatment instead of a tortuous fibrous stricture Both Kidd * who followed up twenty five cases of severe anterior or posterior ruptures and Wheeler† found that results were somewhat unsatisfactory during the first twelve months but ultimately were good

Mortality—Provided the case is seen before urinary extravasation has taken place and retention is relieved or prevented by suprapubic drainage the mortality apart from shock of coincident injuries should be negligible For comparison it is of interest to study Kaufmann s collected figures In uncomplicated ruptures (205 cases) there was a mortality of 14 5 per cent. mainly due to urinary extravasation In association with fracture of the pelvis (48 cases) 40 per cent died.

* Trans. Soc. Internat. d'Urol., July 1921 1 Congrès.
† Brit Journ. Urol., June, 1929, i, 128.

OPERATIONS FOR THE REPAIR OF FISTULA OF THE URETHRA

Before attempting to repair the urethra any *complication which* co-exists must be treated. Thus a stricture is freely cut and fully dilated or urethral calculi are removed. No attempt is made to close the fistula where acute inflammation is present and this especially applies to the fistulæ that follow the rupture of a periurethral abscess.

Efficient drainage of the bladder must be provided suprapubic cystotomy is the only method of drainage that presents a reasonable certainty of success in plastic operations for repair of major defects of the urethral wall. It is performed either a few days before the operation on the urethra or at the same time

FISTULA OF THE PENILE URETHRA

The track is always short and lined by epithelium. A fistula with a very fine calibre may be successfully treated with the galvano-cautery which destroys the lining epithelium but in a larger fistula one of the following plastic operations is necessary

A **Fistula at the base of the glans penis.**—1 Loumeau's operation.* A quadrilateral area surrounding the fistula is denuded of epithelium the lining of the track *is removed and the edges are brought together* by interrupted catgut sutures A flap corresponding to the denuded area in shape and size on the proximal side of the fistula, is undercut and slid distally until it lies over the raw surface. It is then fixed in place by interrupted sutures to the edges of the raw surface.

2. *Dieffenbach's operation.*†—*The* edges of the fistula are excised by a transverse elliptical incision and the raw edges united by fine catgut sutures the knots being tied inwards. The ends of the sutures are drawn through the external meatus and may be removed by gentle traction a few days after the operation The under-surface of the glans penis is denuded of epithelium and a corresponding area is marked out by an incision on the under-surface of the penis or the retracted foreskin the two surfaces being base to base The skin is dissected up over the area and turned forwards like a gangway so that it covers over the freshened surface of the glans and it is stitched in this position.

B **Fistula on the under-surface of the body of the penis.**—There is *great variation in the size of the fistulous opening and in the* extent and density of the surrounding scar tissue. Several operations may be required before the fistula is finally closed. Various operations have been described and the surgeon will select whatever method appears to be suitable for the type of case with which he is dealing

An incision is made in the long axis of the penis with the centre at the fistula. The incision surrounds the fistula and the edge of the

* *IX Congrès Franç. de Chir* Paris, 1895, p. 877
† Operat. Chir., 1, 630.

track is excised The mucous membrane of the urethra and the sheath of the corpus spongiosum are clearly defined The skin is undercut for a sufficient distance to allow it to come together without tension Interrupted catgut sutures are introduced to bring the edges of the mucous membrane together transversely and a second series of stitches unites the sheath of the corpus spongiosum The skin is united in the long axis of the penis by catgut sutures No catheter is placed in the urethra.

When the fistula is large and there is difficulty in obtaining apposition of the skin a longitudinal incision may be made through the skin on each side parallel with the median incision A bridge of skin is thus formed on each side and these bridges are united over the fistula leaving the denuded area to heal without suture. Or a transverse incision may be made below the fistula and the transverse bridge thus obtained slipped forwards over the fistula (Dieffenbach) or a double transverse bridge of skin is used from above and below the fistula (Nélaton) or a flap of skin may be turned over from the anterior surface of the scrotum to repair the defect after excision of the fistula. Benedict has recommended grafts of the whole thickness of the scrotal skin for repairing large cutaneous defects of the penis The flap must be cut half as wide again as the area to be covered since the dartos muscle causes considerable shrinkage of the flap The base of the flap is cut at the end of the first week.

Guyon and Pasteau (Thèse de Paris 1901) closed a large penile fistula by raising three quadrilateral flaps from the proximal and the lateral aspects of the fistula. After the fistula had been pared the median proximal flap was reflected forwards forming a new urethral floor The lateral flaps were then brought together on this and sutured in the middle line covering the exposed raw surface of the median flap

Thomson Walker found two methods useful in penile fistula and urethral defects for preventing the ingrowth of epithelium which reproduces the condition

(1) After repair and suture of the urethra and corpus spongiosum the skin is freely undercut on each side and at each end of the fistulous area but without cutting flaps The anterior and posterior angles of the wound are grasped in forceps and raised up so that the under-surface of the skin on each side of the fistula comes in contact for ½ or ¾ in. in vertical depth. Several mattress-sutures the number depending on the length of the denuded area are placed at the base of this they are of silkworm-gut and pass from epithelial surface to epithelial surface the suture at each end being placed beyond the fistulous area. The cut edges are united by interrupted silkworm gut sutures If there is tension of the skin lateral incisions in the long axis of the penis may be made well away from the median wound The raw under-surface of the skin on either side of the fistula is thus brought into contact for at least ½ to ¾ in. and this apposition extends proximally and distally beyond the fistula.

(2) Where there is likely to be some tension in cases of fistula or defects of the penile or bulbous urethra the skin is widely undercut on each side. After repair of the fistula the skin is turned back on each side and stitched to the skin well out at each side of the fistulous area. The stitches are retained till granulation is established and the skin is then released

A cause of failure in plastic operations on the urethra is the occurrence of erections after operation tearing the stitches. To prevent this the patient is kept under the influence of bromides and small doses of opium A rubber bag filled with crushed ice frequently applied locally is also helpful.

Fistulæ of the Bulbous Urethra

These fistulæ are almost invariably combined with stricture of the urethra, and sometimes also with urethral calculus The preliminary steps of the operation consist in an internal urethrotomy and, if stone is present in its removal.

If a single fistula is present the following operation will suffice The patient is placed in the lithotomy position and a metal sound is introduced into the urethra. A probe is passed along the fistula until it meets the metal sound in the urethra. A circular incision is made round the fistulous opening and the fistulous track dissected out until the metal sound can be felt lying in the urethra. When this is reached, the fibrous wall of the fistula is cut across and removed and any fibrous tissue remaining at the edge of the opening in the urethral wall is clipped away

The wound may be allowed to heal without suture the edges coming together when the thighs are approximated or catgut sutures may be placed in the urethral wall and perineal tissues and silkworm-gut in the skin.

Cathelin's operation.*—A large catheter is introduced into the urethra. A circular cuff of skin at the outer orifice of the fistula is dissected up and the dissection carried along the fistula, which thus forms a funnel. The circular skin flap and tube is then slit up above and below the fistula so as to form the lateral rolls. These rolls are inverted so that the raw surface is outwards and are transversely sutured by Lembert's sutures and the skin sutured over this This operation is best suited for fistulæ and smaller defects.

Multiple fistulæ opening upon the perineum or scrotum without much fibrous induration have usually one opening in the urethra. The tracks may be excised. The operation entails careful and painstaking dissection. If the individual tracks cannot be dissected out they must be laid freely open and scraped with a sharp spoon and as much as possible of the surrounding fibrous tissue cut away The wound is left widely open and packed with iodoform gauze Here again the method of undercutting and turning back and stitching the skin already described is frequently of use

* Chirurgie Urinaire de Guerre, 1919 p. 131.

Where there are multiple fistulæ of the perineum and scrotum *with formation of fibrous tissue* the whole of the fibrous mass should be removed As a stricture is usually present, internal urethrotomy is performed and a large staff is passed into the bladder The patient is than placed in the lithotomy position and a vertical incision made in the middle line of the perineum This is deepened until the urethra is exposed and the groove in the staff can be felt A knife is run along the groove and opens about 1½ in. of the urethra. A gorget is passed along the groove into the bladder the staff withdrawn and a large rubber perineal tube introduced The gorget is removed and the tube clipped with pressure-forceps The excision of the mass of fibrous tissue which contains the fistulæ is now commenced The median incision is carried forwards as far as the fibrous induration can be felt The tissue cuts like a turnip and several small buried collections of pus may be opened From the anterior end of the incision another is commenced which passes out on one or other side keeping at or very near the edge of the indurated tissue and sweeps round to join the median incision at the perineal end behind the fibrous mass This curved incision is deepened so as to remove the large wedge-shaped mass of fibrous tissue which is held aside in toothed forceps as the incision deepens If a nodule of fibrous tissue lying outside the main mass is felt it is also freely removed. A similar incision is made on the other side commencing at the anterior or upper end and working downwards In this way large fibrous masses which cover an area the size of the palm of the hand are removed and a gap remains at the bottom of which lies the urethra.

The wound may be left entirely open or partly closed. When the thighs are approximated the sides come nearer and may meet posteriorly Without placing any tension on the tissues the wound should be closed as far as possible anteriorly and posteriorly by silk-worm-gut stitches passed deeply through the skin and subcutaneous tissue These are left untied until all are in place and are then tied. No attempt is made to close the wall of the urethra. Part of the wound may remain open and this is left to granulate being lightly packed with iodoform gauze. A dressing is applied and retained by a T-bandage.

After treatment in operations for fistula.—The wound is thoroughly flushed daily with antiseptic solution The bowels are kept confined for four days and on the fourth day the tube is removed and a purge given. Before the action of the bowels the wound should be thickly coated with carbolized petroleum jelly which protects it from infection and this is removed after the action is over Antibiotic and sulpha therapy combined are useful in controlling infection during the first week. At the end of a week or ten days a large steel sound is passed along the urethra and a gum-elastic catheter may be tied in for a week or more During healing the patient sits in a hip-bath containing per manganate or boric acid solution for two or three hours daily Healing takes place in from three to four weeks and the resulting scar is usually supple and healthy

Repair of Urethro-rectal Fistula

All complications must be treated before the operation for closure of the fistula is attempted. To attain success it is essential that the rectal opening should be separated from the urethral opening and that the hole in the rectum be independently closed by suture.

Suprapubic cystotomy is performed and a drain inserted. The patient is placed in the exaggerated lithotomy position and a curved prerectal incision is made extending well out to the ischial tuberosities this is deepened by dissection through the tissues of the perineum. The bulb is identified and freed posteriorly and is then hooked upwards where the wall of the fistulous union between the urethra and rectum can be felt. Dissection is carried laterally round the rectum so as to get well beyond the fistula on either side and upwards beyond the fistula so as to isolate it but in doing this the rectal fistula may be enlarged. Dissection is now carried further in order completely to separate the rectum from the prostate and bring the fistula well into view

The next step is to close the openings in the rectum and urethra. The edges of the rectal opening are trimmed and a series of interrupted catgut sutures introduced avoiding the mucous membrane. This is reinforced by a row of Lembert s sutures. The opening in the urethra is trimmed, and a rubber or gum-elastic catheter replaces the metal bougie in the urethra. The edges of the opening are brought together over this by interrupted catgut sutures in two rows. A rubber drain is placed in the middle line and the muscular tissues of the perineum are united with catgut sutures The skin wound is closed around the tube. The catheter in the urethra is removed and a siphon apparatus attached to the suprapubic drain

The perineal tube is removed on the fourth day and the bowels are kept confined for five or six days The suprapubic drainage is continued for fourteen days and then the tube is removed and the wound allowed to heal

Young s operation *—The important feature of this operation is the utilization of the Whitehead principle of freeing the mucosa and submucosa of the rectum and pulling it down so that the diseased portion of the rectal wall can be excised and a healthy rectal surface is presented against the urethral fistula The urethral fistula is closed as in the ordinary operation the rectal sphincter is carefully repaired if injured and suprapubic bladder drainage employed

OPERATIONS FOR ACQUIRED URETHRAL DEFECTS

The operations here described are applicable where a part of the whole circumference is deficient as may be the result of traumatic rupture gunshot wounds or sloughing as in phagedena

Suprapubic cystostomy to divert the urine is a necessary preliminary

* Young and Davis, Practice of Urology Vol. ii, pp. 863–85. W B. Saunders Co.

(A) Plastic Methods

1 **Repair by sliding flaps.**—A large bougie is passed along the penile urethra appearing in the defect and disappearing behind it into the posterior segment of the urethra Median incisions are made over the urethra anterior and posterior to the defect and the urethral tube is exposed on its under and lateral surfaces for ½ in A longitudinal incision is made along either side of the gutter and the skin and mucous membrane are turned over the bougie in two long flaps The exposed ends of the urethra are prepared The flaps are folded over the bougie so that the skin surface is in contact with the instrument to meet in the middle line and are united by a row of Lembert s sutures of fine catgut. At each end the flaps meet the ends of the urethral tube and are carefully sutured to them The perineal tissues over the newly formed urethral segment are dissected and brought together with catgut sutures the skin and subcutaneous tissues are undercut and brought together by sliding and united by interrupted silkworm-gut stitches The bougie is removed and drainage of the bladder through the suprapubic wound established by means of a White s tube

The urethra is left undisturbed and drainage continued for a fortnight. The tube is then removed and the suprapubic wound allowed to heal

2. **Guyon's double-flap operation.**—For this operation the skin must be supple and free from hair Guyon cauterized the skin before the operation in order to destroy the hair

On one side of the urethral gutter a quadrilateral flap is marked out and dissected up with its base to the urethra a second identical flap is marked out and dissected on the other side of the defect with its

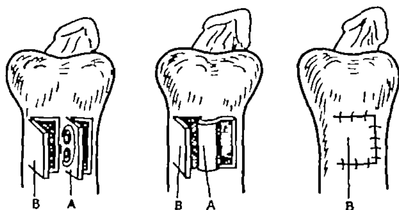


Fig 1067 —Guyon s double-flap method.

1 Flap A, with base near fistula, and flap B, with base distant from fistula, dissected up. 2, Flap A has been sutured over fistula with raw surface outwards. 3, Flap B is sutured, burying flap A, and thus the fistula is doubly covered.

base distant from the urethra. The first flap is turned over and its surface which is buried forms the floor of the urethra at the deficient part The second flap is made to slide over this so as to cover the raw under-surface of the first flap (Fig 1067)

(B) Graft Operations

The cases suitable for this method are similar to those for which the plastic methods are used Here also deviation of the urine by supra pubic cystostomy is an essential preliminary to the plastic operation A great variety of tissues has been transplanted.

1 **Human tissues from the same or another individual.**—The skin has been used in various forms. Keyes used the prepuce. The inner surface of the prepuce was cleaned and packed with antiseptic gauze. A portion of the epithelial inner surface 1½ in by 2 in. in extent was removed and placed in warm boric-acid lotion The stricture of the urethra was excised and the preputial skin graft stitched in position in the roof of the gap left between the ends of the urethra

Dittel used a Thiersch graft rolled into a tube. Von Frisch Le Prevost Mensel Norbury and Thomson Walker performed similar operations Strips of mucous membrane have been taken by Albert and Dittel from the lower lip to close urethral defects Lapiejko operated on three cases stitching the transplanted mucous membrane to the urethra in front and behind and laterally to the soft tissues of the perineum In one case the defect measured 7 cm Portions of mucous membrane taken from other individuals have been used.

Wölfler used mucous membrane from a prolapsed uterus He incised the cartilaginous stricture of the urethra and allowed the gap to granulate. Strips of mucous membrane several centimetres long and 1 to 2 cm. broad were then taken from the mucous membrane covering a prolapsed uterus and laid on the granulating surface of the urethral gap without fixing them with stitches. A catheter was tied in position and the grafts were left undisturbed for five or six days

Vaginal mucous membrane (Legueu and Wölfler) the appendix (Lener Streissler von Augerer Rothschild) the internal saphenous vein (Tanton Jaboulay Carrel Legueu and Rico) and fascia lata have also been used.

2 **Tissues from animals.**—J Hogarth Pringle* grafted lengths of bullock s urethra in 3 cases (2 of extensive defects in the urethral wall, 1 of hypospadias) all of which were successful. In his first case 13 cm of the bullock s urethra were required a second graft was necessary to repair a residual fistula. Suprapubic drainage was used in these cases Gouverneur and Garsin and Legueu used the aorta of a dog Walker strips of intestinal mucous membrane from a rabbit Adams surrounded a catheter lying in the position of the lost segment with a tube of Baer s membrane

Results of plastic methods.—By both methods of repair complete restoration of the urethral canal has frequently been obtained. There is some danger of contraction at the points of union of the repaired with the intact portion of the canal. Sometimes several operations are necessary before the defect is closed

* Ann. Surg., Sept. 1904, xl, 387

Good results have been obtained by autoplastic flap methods where the ends of the urethra had deliberately been brought to the surface and the gap allowed to heal over (Pasteau Iselin) or where this preliminary state developed without premeditation.

Good results were obtained by Mühsam Cealic and Leguen one year one month and twenty months respectively after transplantation of a portion of the saphena vein In a case reported by Gayet and Verguony a post mortem examination showed that the graft of vein had survived but a stricture had formed

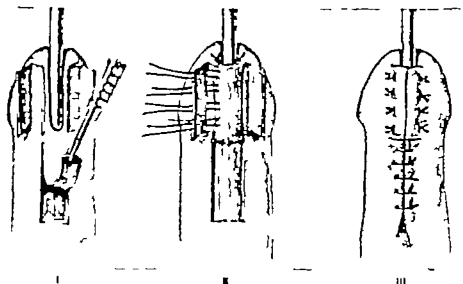
OPERATIONS FOR CONGENITAL DEFECTS OF THE URETHRA

Hypospadias

Three degrees of the deformity are recognized (1) the glandular (2) the penile and (3) the perineal

In (1) *the glandular* the meatus lies in the normal position of the frenal attachment it is often narrow A degree of down-curving may co-exist In (2) *the penile* the opening exists anywhere behind (1) perhaps as far back as the peni-scrotal junction and is usually constricted by a delicate muco-cutaneous fold The penis is down curved by fibrosis in the floor of the urethral groove In (3) *the perineal* the scrotum is split the penis is usually rudimentary and the testicles are undescended the external genitalia bearing a closer resemblance to the female than to the male type

Operative treatment. **General principles.**—The problem of hypospadias is two-fold. Firstly establishing the full urethral defect



I II III

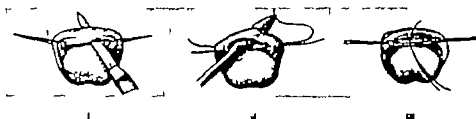
Fig 1068 —Burghard's operation for glandular hypospadias.

I, Incisions, and partial detachment of basal and lateral flaps. II Basal flap turned forward suturing of margins and of lateral flaps. III, Suturing completed.

and redistribution of penile skin and secondly constructing a new urethra to render the patient potent and able to micturate normally The Ombrédanne procedure ignores these principles

It is axiomatic that at certain crucial stages in urethral repair urinary stream must be diverted. Once the urine bursts throu suture line a fistula is inevitable and urine passing over the suture inevitably leads to infection. The correct time for this diversio when the urethral continuity is finally established and is read serve as a pipe As explained later perineal is better than suprap drainage for this purpose Hæmatoma formation and sepsis disastrous therefore meticulous technique fine instruments and sut are imperative The subject of the glandular variety is so handicapped that operative interference is seldom required stream may be difficult to direct but procreation appears to be hindred. Meatotomy may be necessary if the meatus is small. details of a method of repair are sufficiently shown in Fig 1068 (B hard s operation) The penile and perineal types comprise the maj presented for treatment and operation is required in all.

Operations for penile hypospadias. Edmunds operation.—Until method of Edmunds was introduced * all flap operations were ap



i ii iii

Arthur Edmunds operation for hypospadias.
Fig 1069 —Stage I—Securing tube grafts from the prepuce (figs. i, ii, iii)

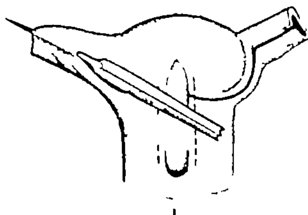
i, The prepuce, stretched by lateral slag sutures, is transfixed and incised 1 mm. from the corona. ii, is made of the slings for suturing the edges of the buttonhole iii, Apposition of intermediate sutures preserve the buttonhole.

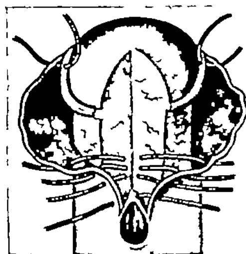
(Reproduced, by permission, from Edmunds, The Lancet, 1926, Feb. 10th.)

fail from the inability to procure apposition of the flaps wit tension owing to the shortage of material available By mobili the prepuce in such a way that it can be slid in two lateral ha to the ventral aspect Edmunds was able to procure ample s (*a*) to cover the raw surface left after full liberation of the fib urethral groove which had held the penis in its characteristic position (*b*) to fashion and suture flaps on the Duplay princ without tension

The operation is not advisable until the fourth or fifth year w there is generally enough tissue to handle. Suprapubic drainag not used because it does not keep the urethra dry for the draina not dependent as with a perineal urethrostomy After removal of catheter the perineal wound heals spontaneously The reason w penile fistula persists is due to the rapid epithelialization of the fistulous edges In a deeper perineal wound healing precedes epithelialization.

First stage—The preputial hood is 'buttonholed' transversely It is steadied by two laterally placed tension sutures transfixed and incised horizontally 1 mm from and parallel with the corona. Sutures





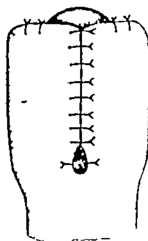


Fig 1070—Stage II—Overcoming the down-curvature by mobilization of the urethra and transferring the skin of the tube grafts to the raw surface on the ventral aspect of the penis.

I, Preputial isthmus divided. The dotted line indicates the margins of the urethral groove from which enough tissue is dissected up or incised to allow of straightening; only the minimum amount should be removed. Incisions from the groove are carried outwards at the level of the corona extending into the preputial flaps and downwards as far as the meatus. These are sufficiently deepened into the subcutaneous tissue and, by teasing out the lax skin, lateral flaps are splayed out resembling elephants' ears. The success of the operation depends upon the efficiency of this stage. II, Application of sutures to the lax flaps to cover the urethral groove. III, When the above is completed the median sutured edge should almost cover the ventral aspect of the glans. The stitches at the meatus have sutured skin to mucosa this may be unnecessary

(Reproduced, by permission, from Edmunds, *The Lancet*, 1926, Feb. 16th.)

unite the edges of the incision and so preserve the buttonhole. (Fig 1069) A constricted meatus is slit backwards and a suture passed between the mucous membrane and the skin

Second stage—(After three months interval) This is the most important stage being designed to correct the down curvature of the penis and to cover the resulting bare area with lax skin It can be best understood by examination of Fig 1070 The penis is held on the

stretch by a tension suture transfixing the glans Through parallel incisions made along its margins the urethral groove with all subjacent fibrous tissue which may include some cavernous tissue is sparingly dissected and teased until the tendency to down-curve is removed and any additional fibrous bands that prevent straightening are cut obliquely The meatus as the result of these manœuvres shrinks towards the base of the penis The preputial isthmus is divided mesially allowing the two halves to fall to the sides of the penis in a dog s ear fashion and into these flaps incisions are carried from the distal end of the bed of the urethral groove (Fig 1070 (i)) The skin edges of these incisions and the margins of the groove bed are undermined and dissected up By a teasing process (like a cook stoning raisins) the lax tissue is opened out into redundant flaps. A series of interrupted sutures is now introduced the hindermost stitch including the anterior angle of the urinary meatus and the rest picking up the underlying tissue as well as the skin edges to ensure an additional blood supply to the flaps The finest sutures of catgut or black ophthalmic silk on round bodied needles preferably of the atraumatic type are used (Fig 1070 (ii)) Thus the edges of loose skin are sutured (*a*) in the midline covering the urethral groove and (*b*) to a narrow free muco-cutaneous margin close to the corona. The breadth of the organ is much increased at the completion of this stage. (Fig 1070 (iii))

Third stage—(Three months later) A new urethra is formed on the Duplay principle. A narrow lead rod is passed far enough through the meatus to steady the penis and the operation field is further stabilized by a tension stitch transfixing the tip of the glans and this is tied to a loop in the lead rod (Fig 1071 (i)) Incisions are made on either side of the rod each far enough from the midline to give, when the two are sutured together over the rod an amply wide new urethral channel. These incisions made at unequal distances from the midline are carried well forward diverging anteriorly at the glans to allow for contraction and retraction of the new meatus posteriorly they meet 8 mm. behind the existing meatus. The inner edges of the incisions are dissected up as sparingly as possible to preserve vascularity compatible with ease of suturing over the lead rod in the formation of the new urethra. Interrupted stitches (of conjunctival silk) are passed from behind forwards the first including the meatus all are passed and tied in such a way that the knots lie within the urethral channel (Fig 1071 (ii)) The outer margins of the incision are then sparingly freed and sutured over the new urethral floor with the finest ophthalmic silkworm gut vertical mattress sutures long ago described by Edmunds are employed. These are tied round parallel rubber strips which act as splints (Fig 1071 (iii)) Gauze soaked in 1 in 8 000 flavine and paraffin solution is preferable as a dressing

The precaution of making the urethral incisions at unequal distances from the midline avoids coincidence of the lines of union in the two

layers If a fistula forms at the site of the original meatus an incision is made around it The skin retracts allowing the mucous membrane to be seen Finest silk sutures are passed through the mucous membrane and tied but their ends are left long A straight needle threaded with fine silkworm gut is passed eye-end first through the meatus and

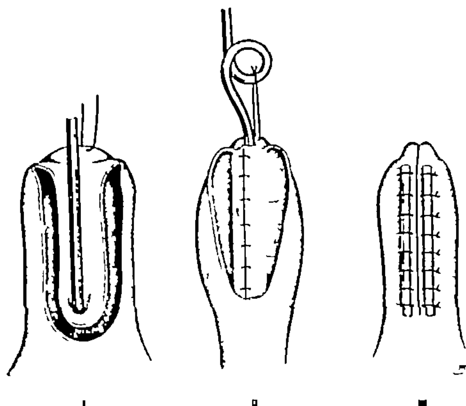


Fig 1071 —Stage III—Making the new urethra. Duplay s principle.

I, A lead rod is placed in the urethra and supporting stitch holding the glans is tied to bend to it. The urethra is formed from flaps raised on either side by incisions at unequal distances from the rod, which meet proximal to the meatus. The rod is the mould upon which the urethra is fashioned. The calibre of the new urethra depends upon the distance between the linear incisions and the laxity of the intervening skin. To preserve vitality skin margins are raised sparingly and should include as great thickness as possible. II, The new urethra has been formed by sutures, the knots of which lie within the lumen. The covering layer of skin has not yet been sutured, III, The covering skin flaps are sutured by the Edmonds vertical mattress sutures tied over strips of rubber which splint the edges. Note the extent to which the glans is covered by the urethra to provide an anteriorly situated new meatus. This controls the future direction of the urine stream.

(Re-drawn by permission of Mr Arthur Edmonds from illustrations in The Lancet and the Medical Press and Circular)

presents through the fistula the long loose ends are collected into the silkworm gut loop and drawn outside the meatus The skin is sutured.

This operation may if required be used in a simple form for cure of glandular hypospadias as an alternative to the method illustrated in Fig 1071 especially if there is a degree of associated down-curvature.

The results of this operation for each form of hypospadias have been eminently satisfactory and in the majority such anatomical perfection has been achieved by the originator as to defy recognition of the previous deformity even in those extreme instances where doubt had existed of the sex to which the individual should be allocated For further details the reader should consult the original papers cited

Denis Browne's operation.*—Denis Browne has established the principle that if a strap of epithelium is buried under the skin of the penis it will inevitably form a tube. The operation also takes advantage of the immunity of the penile skin to keloid formation and contraction.

Preliminary freeing of the flexed penis is undertaken at about the age of eighteen months.

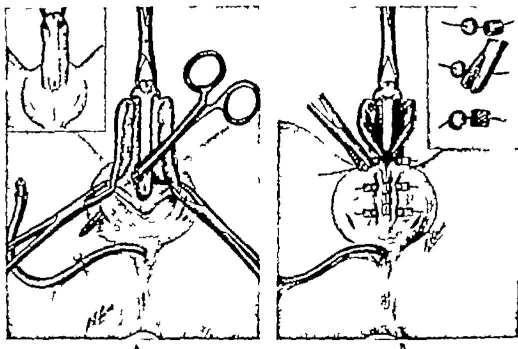


Fig. 1072.—Denis Browne's operation for hypospadias.

A. Outline of incision for mid-scrotal hypospadias (dissection of the lateral flaps that are to cover in the strip of skin that is to form the new urethra) and formation of drainage outlets through the halves of the scrotum. B. Sewing of lateral flaps over new urethral strip by a combination of double-stop sutures to take tension and fine catgut to adjust skin edges. (*Both figures are from Postgraduate Medical Journal. M. Denis Browne.*)

Construction of the urethra is done at about four years of age. Preliminary perineal drainage is instituted, and then flaps of skin are raised on either side of the urethral groove. This leaves a central strap of skin from the urethral orifice to the tip of the glans which is buried by suturing over it the laterally raised flaps. Tension on these sutured flaps is eased by a longitudinal incision on the dorsum of the penis.

Denis Browne emphasizes the importance of using his "double-stop" tension sutures which do not damage the fragile skin.

This operation has been done by various surgeons at the Hospital for Sick Children in 184 cases † with only 8 fistulæ. It has replaced all others in children with hypospadias, and many urologists prefer it also in adults.

Choice of methods for urethral construction.—Local flaps, tubed pedicles and free grafts can be used. The after results of Edmunds' operation have proved the merits of local flaps where provision has

* *Proc. Roy. Soc. of Med.*, 1949, xlii, 466.
† *Surgery, St. Louis*, 1953, xxxiv, 787.

been made for them by suitable preparation of the penis Tubed pedicles which in other regions have been shown by Gillies to offer wide possibilities have so far been little used. As long ago however as 1901 Mayo* constructed a skin lined tube from the prepuce and towards the root of the penis which was divided posteriorly and hinged at the dorsal aspect of the corona. It was then placed in a tunnel made in the glans with a trocar and cannula and the free end was thus brought into contact with the existing meatus to which it could eventually be joined.

Revival of interest in free grafts has been stimulated by A. H McIndoe † who submits that the great success of the Esser‡ principle of inlay grafting in its modern form appears to offer the most reasonable method of constructing a hairless urethra. Nové-Josserand the pioneer of this method of urethral construction§ failed, according to McIndoe not so much from a faulty surgical conception as from imperfect after treatment for stenosis is inevitable unless a distended state of the grafted tunnel is maintained for six months a period exceeding by a safe margin the contractile phase of grafted skin

McIndoe's‖ operation.—The operation is performed about the eighth year the preparation of the penis however by the Edmunds technique is carried out about the fourth year A Thiersch graft from the inner side of the arm is laid upon and attached with 6/0 catgut to a length of gum elastic catheter which easily fits inside the barrel of the specially-designed trocar-cannula. Having tunnelled the penis with this instrument from the meatus to and through the glans the handle and point are detached leaving an open tube into which the graft-covered catheter is inserted. The cannula is withdrawn over the catheter which is left *in situ* thus allowing the raw surface of the graft to make and retain contact with the tunnel wall The catheter is fixed by a simple device The operation is completed by passing another catheter up into the bladder where it will remain for 48 hours to divert the urine The graft bearing catheter is removed on the tenth day and immediately replaced by a similar-sized instrument after an antiseptic urethral wash Similar replacements are continued up to six months and act like the gold sleepers which jewellers use after ear piercing When the contractile phase should be over the dilator is left out and end to-end anastomosis is performed by a flap method closely resembling the Edmunds modification of the Duplay technique It is important to secure urinary diversion at this stage by perineal urethrostomy The special advantages claimed for this operation are that it is fairly simple to perform fistulæ are unlikely and the new meatus is ideally situated at the tip of the glans. Further it can be employed successfully and, indeed

* *Journ. Amer Med Assoc*, April, 1901 xxxvi, 1157
† *Brit Med Journ*, Feb. 1937 i, 385
‡ *Ann Surg*, 1917, lxv, 307
§ *Journ. d'Urol. Méd. Chir* 1914 v 303.
‖ *Amer Journ Surg* Oct. 1937 xxxviii, 176.

has its best application in adults where repeated failures have left the penis in a sheath of scar tissue McIndoe* states that he has completed this operation upon 85 cases with excellent results

EPISPADIAS

The following operation was described by Cantwell† in 1895 Young ‡ unaware of Cantwell s article described the same method independently in 1918 The best age to select is about 10 years

In epispadias the urethra is represented by a shallow gutter lined with mucous membrane on the dorsum of the penis The meatus is situated at the base of the penis and opens direct into the bladder There is usually complete absence of a vesical sphincter In extroversion of the bladder epispadias is a part of the deformity The corpora cavernosa in a normal penis are so intimately attached that it is impossible to separate them without injuring the bodies themselves In epispadias they can be readily separated being connected only by some areolar tissue

Perineal drainage is first established A finger is introduced into the bladder through the gaping meatus the perineum pushed down and an incision made through which a perineal drainage tube is introduced Two parallel incisions are made on the dorsum of the penis from the symphysis pubis to the extremity of the glans along the lines of union of the mucous membrane and the skin The incisions are deepened to the corpora cavernosa, and carried backwards to join above the bladder opening

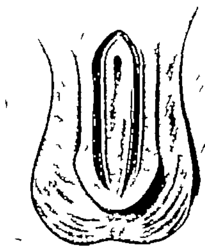


Fig 1073 —Operation for epispadias incision.

A flap is made of the whole urethra attached at the base of the penis. This is held aside and the corpora cavernosa are separated by blunt dissection. (Figs 1073–4) The urethral flap is laid in the gutter thus formed and held in position by two sutures through mucous membrane and skin tied on the under-surface of the penis A catheter is then laid in the urethra, and a canal is formed by continuous suture of the free edges of the mucous membrane Above it the corpora cavernosa are brought together and retained by a continuous suture The skin can usually be brought together over this Some deep sutures are placed

* *Brit. Journ. Plastic Surg* 1948, i, 29.
† *Ann. Surg*, xxii, 689
‡ *Journ. Urol.*, 1918, ii, 237

in the skin and fat of the pubes. Cantwell leaves the catheter in the newly formed urethra for several days in order to prevent contraction.

Young detaches the urethra from one corpus cavernosum only, leaving it attached to the other corpus, which is rotated sufficiently to bury the new urethra. This provides a better blood supply for the new urethra.

This operation provides no control over the escape of urine, and in cases where there was previous incontinence an apparatus to collect the urine will have to be worn. Subsequently, however, Young* described two cases, one male and one female, where coexisting incontinence had been cured by combining an intravesical operation in which the bladder and urethra are laid into one by a long anterior incision made on a curved clamp as a guide. The sphincter is sutured anteriorly and the bladder closed, except for a small drainage tube, before proceeding to reconstruction of the urethra and penis in the male.

The successful formation of a sphincter permitting a controlled stream capable of being projected beyond the penis has led to the opinion amongst some surgeons that the formation of a completed urethra may be regarded as superfluous.

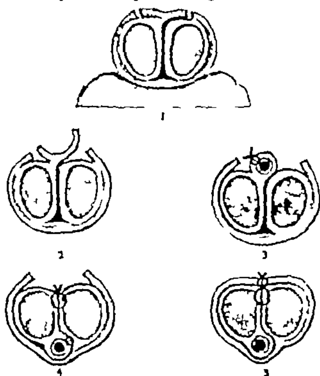


Fig. 1074.—Operation for epispadias: penis in section, showing (1) lines of dissection, with scrotum below; (2) dorsal gutter dissected and corpora cavernosa separated; (3) urethra formed of dorsal gutter and complete dissection of right corpus cavernosum; (4) urethra sunk between and below corpora cavernosa; (5) completed operation.

A. R. Thompson† introduced an operation in which he utilized the rectus muscle to form a sphincter. Certain anatomical facts were ascertained before performing the operation. The twelfth dorsal nerve supplies the lower two-thirds of that portion of the rectus which lies below the umbilicus. Two terminal branches are formed, the one passes upwards and the other downwards. The ilio-hypogastric nerve does not supply the lower end of the rectus; the lower portion of the rectus can therefore be dissected away from its sheath without the surgeon seeing or damaging the nerve supply. The blood supply is drawn from the deep epigastric, which runs beneath the muscle

* Journ. Urol., April, 1936, xxxv, 417. † Lancet, 1920, ii, 780.

adherent to it rather than to the sheath Although a case was recorded where the patient held his urine for one-and-a half hours when in bed and, when he voided urine the stream was projected forwards and with force on the whole this ingenious attempt to provide a vesical sphincter has not stood the test of time and is no longer advised by its originator

The problem in urethral defects with urinary incontinence lies in the choice between efforts at construction of the urethra supplemented by formation of a sphincter either from the natural one or by plastic adaptation of an extraneous muscle and discarding the natural outlets by substituting the large bowel for the bladder and the anal sphincters. Grey Turner and others have shown the results of ureter implantation into the colon to be so satisfactory that there are good reasons for preferring this operation Further it can be carried out at a considerably earlier age any time after the fourth year at the most only two operations will be required, and the child and parents will be spared the anxiety of long delays and repeated operations which may only end in failure

CHAPTFR XLIV

OPERATIONS ON THE PENIS AND TESTICLE

By JOHN EVERIDGE
Revised by HENRY K VERNON

CIRCUMCISION

This operation is subjected to variations according to whether the patient is an adult or an infant In the latter healing is more rapid sensibility to pain less acute and post-operative erections negligible. Hence a speedier operation not requiring the same refinement of technique as in an adult can be done.

The operation in an infant —Besides speed care must be taken not to remove too much or too little skin or mucous membrane to avoid damage to the glans and to procure hæmostasis The surgeon should also examine the external meatus to make sure that this is not unduly small

Since general anæsthesia has been responsible for many tragedies in this minor operation it is most important to insist that there shall be someone present who has no other duty than to administer the anæsthetic The not uncommon practice of one and the same person giving the anæsthetic and then hurriedly performing the operation cannot be justified. Sometimes it may be necessary to evade the risk by doing without anæsthesia and operating in the first three or four weeks of life when sensibility to pain is low The assistance of a capable nurse who can be relied upon to hold the child satisfactorily is essential She should be seated on a low chair with a large firm pillow on her lap The child s legs should be firmly grasped just above the ankles and held up in the lithotomy position at the same time she checks movement of the arms by anchoring them beneath her elbows The surgeon will be seated opposite the perineum. The end of the prepuce is held in a pair of forceps and a narrow clamp or sinus forceps placed dorsi ventrally downwards and forwards The skin beyond is then cut across with sharp scissors leaving the con nective-tissue covering of the mucous layer exposed. After removing the clamp three artery forceps are placed on the cut edge of the mucous membrane two dorsally adjacent to the midline and one ventrally in the midline A mesial cut is made with scissors between the dorsal forceps to a point just distal to the corona The mucous membrane is peeled off the glans firm adhesion between the two occasionally offering some difficulty The cuts are carried laterally parallel to the corona meeting mesially below Bleeding points are picked up with forceps the ultimate hæmostasis being secured by their

inclusion in sutures Four sutures are usually all that are necessary two lateral one dorsal and one ventral More may be required for hæmostatic purposes They are best introduced on a straight needle with a narrow cutting edge and fine catgut is the most suitable material. Better apposition of the edges is secured when the skin is traversed before the mucous membrane Care should be taken to avoid puncturing the glans as troublesome hæmorrhage might result.

When the operation is performed within two to three weeks of birth no suturing is required the mucous membrane can simply be folded back after the dorsal midline cut has been made

The operation in an adult. (Fig 1075)—The clamp method may be suitable but as a rule is not so satisfactory and is unnecessary Three artery forceps are placed on the free edge of the prepuce two

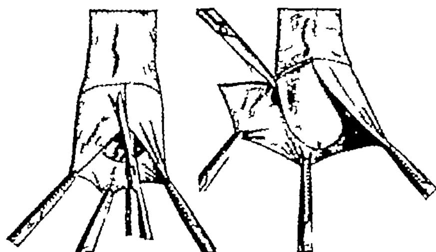


Fig 1075 —Circumcision dorsal view

dorsally and one ventrally One blade of a pair of blunt-pointed scissors is introduced between the prepuce and glans and a mesial cut made to a point ½ in distal to the corona. Care should be taken to avoid undue traction on the forceps as otherwise it might be found when the skin retracts that the cut had extended to the body of the penis an accident which could also have been prevented by marking the line of the encircling cut before traction The prepuce is then divided laterally from the proximal point of the first incision At the frænum the two incisions will meet. All spouting arteries should be caught and tied A continuous suture of fine catgut, uniting skin to mucous membrane is introduced to secure good apposition as well as efficient hæmostasis of the smaller vessels A suitable dressing consists of ribbon gauze soaked in 1 1 000 flavine and liquid paraffin equal parts adapted to the coronal region. A loose piece of gauze is placed over the whole penis and removed when micturition takes place

Anæsthesia in circumcision.—In adults the more recently introduced narcotics evipan or pentothal will generally provide a sufficient depth

and length of anæsthesia if preceded by omnopon and scopolamine

If **local anæsthesia** is preferred a solution of 1 per cent *novocain* is introduced by a series of punctures with a very fine hypodermic needle into the deep layers of the penile skin at the level of the corona producing a series of wheals which become confluent and form a circle To anæsthetize the mucous membrane the needle must be introduced into the loose submucous cellular tissue by direct puncture if the prepuce can be retracted if it cannot by piercing at the mucocutaneous margin of the preputial orifice Assuming that it is

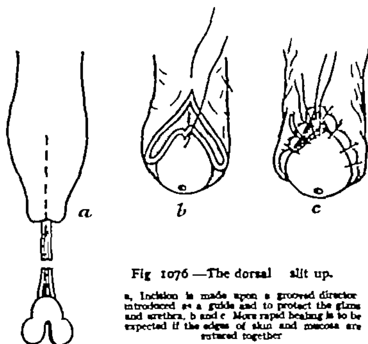


Fig 1076 —The dorsal slit up.

a, Incision is made upon a grooved director introduced as a guide and to protect the glans and urethra, b and c More rapid healing is to be expected if the edges of skin and mucosa are sutured together

introduced into the right layer the novocain spreads readily ballooning the loose connective tissue The region of the frænum is the most sensitive and special care is necessary to infiltrate freely in this situation.

Nerve-blocking of the dorsal nerve of the penis carried out at the base of the organ is less certain and for this operation would probably have to be reinforced by local infiltration

Phimosis is not necessarily treated by complete circumcision This operation is often refused by the patient and unwarranted since the only objects may be to gain approach to the meatus for aseptic instrumentation or to provide opportunity for sub-preputial cleanliness Modified circumcision by which the glans remains protected by its natural covering is especially desirable for adults and the aged in whom permanent exposure of the glans may be a source of irritation. A dorsal slit-up will give the necessary exposure for aseptic instrumentation and a few sutures to approximate the edges will give a neater result preventing healing by granulation and fibrosis such as might cause relapse (Fig 1076) *A short frænum* may be lengthened

by an incision made transversely and sutured longitudinally (Fig 1077)

In *some cases* where the prepuce on retraction presents a tight cord like ring in the coronal sulcus (the first stage of paraphimosis) permanent relief may be obtained by *one or two longitudinal incisions which divide the whole thickness of the constricting band but do not* of necessity encroach into the free prepuce. If these incisions are sutured transversely sufficient length will be gained to secure laxity even during turgescence. (Fig 1078)



Fig 1077 —Lengthening the frænum preputiæ

The frænum is stretched by retraction and divided transversely It is sutured with apposition of the edges in the long axis of the penis.

Relief of paraphimosis is required in the presence of irreducible retraction of the prepuce with œdema and perhaps sloughing from vascular strangulation. A grooved director is coaxed under the prepuce and constricting ring in the midline dorsally and all tissue

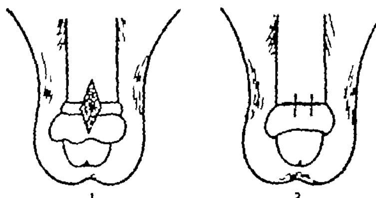


Fig 1078 —Operation for paraphimosis.

1 Division of the constricting ring. 2, Suture of the skin and subcutaneous tissue in transverse axis.

to it is divided. The œdema rapidly subsides and replacement is carried out Cosmetic circumcision can be performed at a later date if necessary

Operation for Contracted Meatus

Meatotomy—A narrow bladed knife is inserted and a downward cut made taking care to include a sufficient length of the urethra. The passage of a large bougie will prove the adequacy of the incision. Subsequent dilatation is regulated by the rapidity of recontraction.

The tendency to relapse is diminished by suturing the cut edges of the skin to the mucous membrane which is drawn out of the depth of the urethra into which it has sunk by toothed forceps Raw surfaces will be covered in this way and if primary union takes place healing by granulation and future fibrosis is reduced to a minimum (Fig 1079)

It is important after the operation to separate the lips of the meatus once daily This can be done by soaking the meatus with some mild antiseptic fluid and then separating the two suture lines by wiping with a piece of gauze Another method is to pass a small straight steel daily

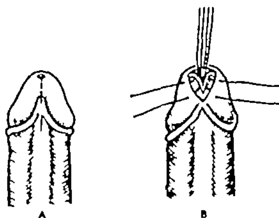


Fig 1079 —Meatotomy

The meatus is incised towards the fraenum ( ) I most cases suturing is unnecessary but, if desired, it may be carried out as in ( ), the sutures transfixing the skin and mucous membrane.

AMPUTATION OF THE PENIS

This operation is rarely called for in conditions other than malignant disease. The nature of the amputation is controlled by the situation and extent of the growth. Reluctance to perform an operation producing so far reaching a psychological as well as physical defect has encouraged surgeons to welcome a prospect of cure by radium and X-ray therapy Both these radio-active agents have their place and after radium especially hopeful results are seen in certain types of growth but as yet the end results do not appear to warrant a reversal of the older teaching—except for the most superficial growths or for the purpose of cleaning up a foul fungating mass as a preliminary to operation

When the growth is limited to the prepuce glans or corona and the organ is long enough to leave a stump lying well clear of the scrotum a partial amputation may be employed or radiotherapy given especially if the patient is under 50 years of age When on the other hand the corpora cavernosa are implicated complete amputation offers the best hope of eradication In all cases excision of glands in the groin should be part of the routine Where the extent of the growth has warranted complete amputation extirpation of the inguinal glands and surrounding cellular tissue is as much a part

of the operation as is the clearing of the axilla in radical amputation for carcinoma of the breast and similarly block excision of the whole area to include all lymphatics in an unbroken chain should be the objective.

For carcinoma of the penis the surgeon has the choice of the following methods of treatment —

1 Partial amputation (*a*) with excision of inguinal glands (*b*) with radiotherapy to the inguinal fields if glands are very extensive or the general condition precludes excision

2 Total amputation with (*a*) or (*b*) as above Radiotherapy may be used as a supplement to excision where excision may not be complete

3 Radium therapy to the penis (*a*) alone in very early or very advanced cases (*b*) as a preliminary to some form of amputation (*c*) with dissection of the lymphatic fields (*d*) with X ray therapy to the lymphatic fields if too advanced for excision and glands can be felt in the iliac fossa.

4 Emasculation with block dissection of the lymphatic field, supplemented by X ray therapy

I Partial Amputation

Two types of operation are available—(*a*) the flap (*b*) the circular

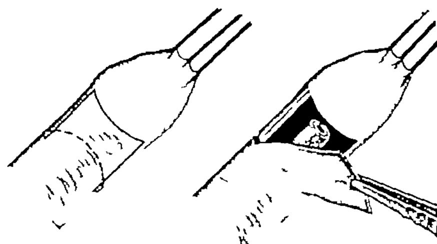


Fig. 1080 —Partial amputation of penis with long ventral flap incision, raising of flap, and section of urethra.

or elliptical A tourniquet should be employed and for this either a piece of rubber tubing or a rubber catheter is suitable.

(*a*) **The flap method.**—Dorsi ventral flaps are employed and use may be made of a long dorsal and short ventral flap or vice versa. For the latter an advantage claimed is that the urethra piercing the long flap will be at some distance from the line of apposition and hence contamination of the wound with urine and consequent irritation or sepsis is less likely

When the **long dorsal flap** is used it must be half the circumference of the penis in width and in length equal to the diameter of the organ The ventral flap is about ¾ in long Both flaps including all tissue to the tunics of the corpora cavernosa and corpus spongiosum are dissected back to their bases (Fig 1080) A narrow bladed knife is introduced between the urethra and the corpora cavernosa and a length of urethra (about ¾ in) is isolated by passing it forwards and cut across distally The corpora cavernosa are transfixed and divided at the level of the basal attachment of the flaps Ligatures having been placed upon the dorsal vessels and those in the corpora cavernosa the tourniquet is removed and any other bleeding points are dealt with. There is usually considerable oozing from the spongy tissue and in the corpora cavernosa this may be checked by suturing the tunica albuginea over the cut surface. The dorsal flap is punctured

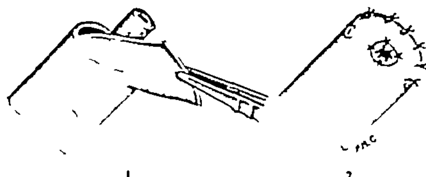


Fig 1081 —Partial amputation of penis.

1 Flap and segment of urethra prepared. 2 Urethra taken through buttonhole in base of flap and sutured to the skin beyond its edges; flap sutured in position.

and the urethral stump brought through the hole. The end of the urethra is then split and each half is sutured not to the margin of the puncture but to the skin beyond it By this method a rosette of redundant urethra is left and this is the only way to prevent subsequent contraction of the new meatus (Fig 1081)

In the **long ventral flap** method there are no essential differences in the operation apart from the relative lengths of the flaps The button hole to transmit the urethra is made in this flap

(*b*) **The circular amputation.**—A circular incision is made around the organ ¾ in in front of the position where the corpora cavernosa are to be cut across The skin is retracted and the corpora cavernosa are incised vertically until the urethra in its spongy investment is exposed. The urethra is dissected forwards and separated for ¾ in before it in turn is cut across at this distance anterior to the divided corpora cavernosa. The skin edges are sutured leaving a gap through which the urethra will pass The urethra projecting through this opening is incised longitudinally in its dorsal and ventral walls thus leaving ½ in. long flaps which are sutured to the neighbouring skin

The elliptical amputation is performed in a similar way except that the circular incision is made obliquely downwards and forwards It appears to present no special advantages over the other methods.

At the conclusion of the operation a catheter may be introduced through the new urethral opening but as this may aggravate sepsis it is better avoided in most cases

Complications.—Oozing from the cavernous tissue is very apt to give a troublesome hæmatoma. Remembering this care should be

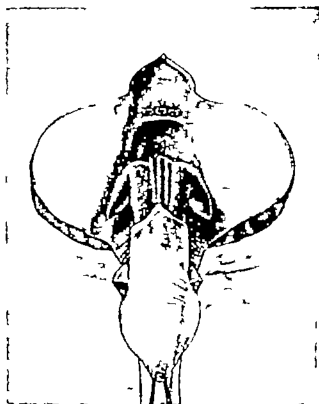


Fig. 1082.—Total amputation of penis crura partly detached, dorsal vessels ligatured. The edges of the split scrotum are seen retracted.

taken during the operation with the mattress sutures closing the tunica over the cut surfaces of the corpora cavernosa and leaving a sufficient interval between the interrupted sutures A hæmatoma is likely to suppurate and pus may even track up in and around the corpora cavernosa requiring evacuation.

Stenosis of the urethral outlet may occur in spite of the precautionary measure of splitting the new orifice A careful look-out should be kept for this contraction should it occur dilatation or incision will be required.

II Total Amputation

The method of complete eradication usually adopted varies little in detail from that originally described by Sir A Pearce Gould.* He

* *Lancet*, 1883, i, 821

pointed out the necessity for removing the corpora cavernosa in their entire length but did not in the original communication extend the scope of the operation to the lymphatic field

Technique —With the patient in the lithotomy position and a steel bougie in the urethra the base of the penis is encircled by an incision

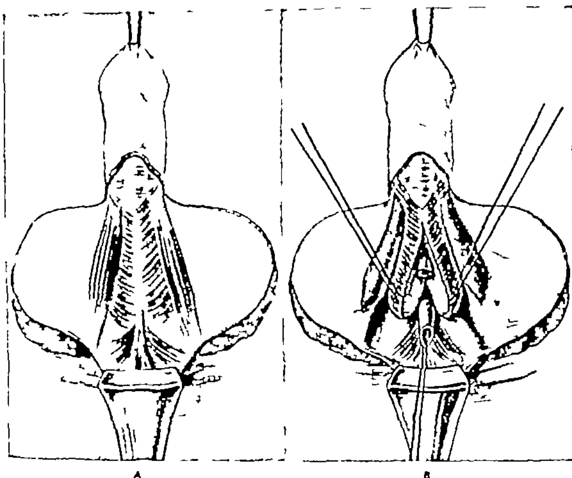


Fig. 1083.—Total amputation of penis A. Incision and dissection of perineal muscles B dissection of crura and section of urethra.

which is continued backwards through the middle line of the scrotum and perineum ending about 1 in in front of the anus

The penis is separated from the pubic symphysis by dividing the suspensory ligament and thrown downwards (Fig 1082.) The scrotum is split through the septum and as the perineal part of the incision is deepened the urethra is identified and the bulb exposed. (Fig 1083 A) The bougie is removed and the urethra separated from the triangular ligament The divergence of the corpora cavernosa is now apparent and their crura which are closely attached to the pubic and ischial rami will require separation from those bones by a raspatory as far back as the body of the ischium At this stage troublesome hæmorrhage may occur from division of the deep arteries of the penis which pierce the corpora under cover of the pubic arches The vessels should

be secured whilst stripping off the corpora and before they are divided if possible A piece of urethra 2 in. long is isolated anterior to the triangular ligament (Fig 1098 B) and held in catgut slings while the edges of the whole length of the wound are brought together by silk worm-gut stitches except for gaps left for the urethra and a rubber drain By arranging the first of these gaps vertically below where the urethra leaves the triangular ligament the urethra is given the shortest and most direct course moreover the excess length already prepared will allow ½ to ¾ in redundancy beyond the skin which can be fashioned into lateral flaps These flaps are stitched to the surface at a distance from the edges of the wound, without tension and allowing for the possible increased tension caused by post operative œdema Some surgeons prefer to expose and divide the urethra immediately after making the incisions and before detaching the penis from the symphysis pubis

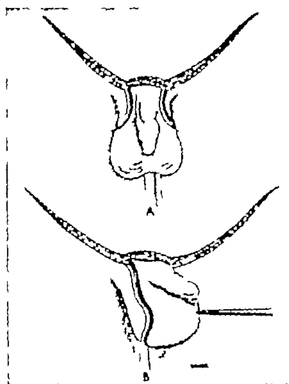


Fig 1084 —Incisional approach for amputation of the penis with inguinal gland dissection.
(From Diseases of the Penis and Urethra. D'Arcy McCrea.)

If the inguinal regions are to be cleared on the same occasion the procedure described should be preceded by this important step Curved incisions should be made in each groin extending from the anterior superior spines down to the base of the penis Through these all glands fat and fascia are freed *en masse* elevated externally and thrown down towards the penis to avoid division of the lymphatic vessels This step involves removal of subcutaneous fat and deep fascia down to the surface of the external oblique and over an area at least 2½ in on either side of the incision. In this way all the gland bearing structures are removed including those over the upper part of the femoral vessels The principal vessels requiring ligation are the superficial circumflex iliac epigastric and external pudic. These may be of considerable size and must be carefully caught as they leave the trunk of the femoral. Near the large vessel gauze stripping is very helpful The internal saphenous vein will usually have to be divided. On theoretical grounds removal of the inguinal glands and penis *en bloc* is sound surgery but it must be remembered that the enlargement of the glands is frequently due to sepsis and their removal

may cause severe post-operative infection The glandular enlargement often subsides after removal of the primary growth In many cases therefore it is preferable to perform a block dissection of the groins at a later date

Removal of the testicles and scrotum at the same time is advisable on the grounds (1) that the tissue might otherwise be the seat of recurrence but this is very rare (2) that the scrotum might be an embarrassment in the new method of micturition and especially (3) that it is desirable for physiological reasons to procure complete emasculation whenever the whole penis has to be sacrificed

Where castration has been decided upon a curved transverse incision is made from groin to groin crossing the middle line immediately above the penis Lateral incisions include the sides of the scrotum and meet in the midline just behind it (Fig 1084) Thence a short median incision is made to a point 1 in in front of the anus The inguinal regions are first of all cleared and the cords tied and divided at the external abdominal rings The cords and all cellular tissue glands testes and scrotum are thrown downwards in continuity The penis the corpora cavernosa and urethra are dealt with as in the operation described above and the wound is sutured the same precautions being taken with the urethral stump

It does not appear necessary to leave a catheter *in situ* at the completion of these operations Trouble with subsequent micturition is unusual and stenosis of the new urethral orifice is less often met than after partial amputation but it is wise to pass a straight bougie at intervals after operation The initial shock from the operation may be somewhat severe but the result in its bearing on the function of micturition is usually very satisfactory

RADICAL PARTIAL AMPUTATION (H H Young's operation)

Hugh H. Young believing that the probability of local recurrence is minimal although observations of earlier surgeons did not support this view devised a more conservative amputation even in the presence of a growth of the type generally considered to be outside the scope of partial amputation No conservatism is however introduced into the clearance of the lymphatic field the inguinal area and intervening lymphatics being attacked on most radical lines The operation is commenced peripherally the clearance of the groins being the first step and dissection exposes the inguinal canals the external rings the cords and coverings The crural region is also assiduously cleared and fascia and fat accompanying the cords into the scrotum are followed and dissected away The divided corpora cavernosa and spongiosum are covered by a skin flap from the dorsum of the penis This flap does not include Buck's fascia, which has been dissected away from beneath it A detailed description and further particulars of this operation are given by H H Young *

* *Practice in Urology* 1926, Vol. ii, p. 448.

Results of Operations for Carcinoma of the Penis

Demarquay referring to the operative sequelæ mentions retraction of stump retraction of the urethral orifice with abscess fistula stricture of the new meatus bacterial infection of the inguinal glands recurrence generalization of the disease aggravation of the poor general condition mental changes loss of sexual power To these might be added œdema of the legs from interference with lymphatic return after clearance of the groin.

Among the earlier authors Butlin* collected and published, in 1900 details of 65 cases which had been treated by amputation in the majority the inguinal glands were not removed 23 i e. 35 per cent. showed no recurrence in three years Of the rest there was penile recurrence in 8 and in 6 cases in the inguinal glands The exact nature of the operations upon the penis and glands is not stated. Barney† collected 100 cases. He found 89 per cent of recurrences in the first year and 12 per cent. after the fifth year Of these 21 cases were local, in the penis or stump 2 were in the groin alone and 8 in both groin and penis Thus it is clear that freedom from recurrence in the conventional three year limit is no indication of a cure In this disease variability in malignancy is most striking many cases seeming to run an almost benign course. Indeed Barney mentions one patient who refused operation and eloped eleven years later he was still alive.

Only by reference to the statistics of surgeons collected before the radiotherapeutic era can the results of operative measures alone be fairly assessed for probably in every modern centre since the advent of radium and X ray therapy these measures will have been given trial and will have influenced the effect of operative surgery Thus all recent statistics can only be derived from a combination of methods. (*See* p 2451)

Radium and other Agents in the Treatment of Carcinoma of the Penis

Modern methods include the high frequency current which may be used as a coagulating or cutting agent. The cutting current is useful for removing massive proliferative growths as a prelude to radium therapy or amputation indeed, it may be used for some of the steps in an amputation but should be avoided in skin incisions where primary union is expected as it may delay healing The coagulating current is especially valuable in reducing a highly vascular neoplasm and will then be used in combination with the cutting current.

Radium.—Either the element in screened needles or its emanations in the form of radon seeds may be used Surface or interstitial application is as yet a matter of individual choice the inclination naturally being to embed in small circumscribed growths but according

* *Operative Surgery of Malignant Disease* 2nd Ed.
† *Ann. Surg.*, 1907 xlvi, 890.

to Hutchison * there is a tendency to discard interstitial methods and to use only surface application by means of which the whole shaft of penis can be homogeneously irradiated He uses a standard cylinder 10 7 cm long 5 cm across in external diameter 1 cm thick giving an internal diameter of 3 cm The radium needles are placed around the periphery of the cylinder in four bands or belts the long axis of the needles being parallel with the axis of the cylinder Each band has six 1 mg needles (1 5 cm active length 0 5 mm P + filter) at equal distance around the circumference This mould is applied for 240 hours giving about 5 000 to 6 000 *r* dose He reports a series of 10 cases over 1 year but under 2 years after treatment —alive and well 9 cases of which 5 were treated by radium alone and 4 by radium previous to amputation

Certain types of growth respond more readily than others The hypertrophic varieties without much infection and with little infiltration are the most favourable the ulcerating varieties are less so nevertheless it is often surprising how occasionally a foul fungating ulcer will heal with minimal scar formation The infiltrating type where the substance of the glans or corpora cavernosa is involved seldom reacts favourably to radiotherapy and earlier amputation is required.

Radium is little use for glandular nodes excision or X ray treatment independently or combined are accepted as the best measures

Thus the tendency of treatment to-day is —

(*a*) to treat the primary growth with radium and if there is failure to respond or recurrence to amputate

(*b*) To clear the inguinal fields by excision *in every case* assuming that they are in an operable state otherwise deep X ray therapy should be used.

Desaive and Ramioul† recommend radiotherapy to the glandular field followed by block dissection and later by further local radiotherapy

Results of Combined Methods of Treatment

The question of treatment of the inguinal lymphatic field is most controversial for although glandular metastases are to be expected in all cases sooner or later yet the observations of Barney Barringer and Dean and others find the incidence to be no higher than 40 per cent. This figure no doubt is low enough to influence adversely the tendency to perform radical or prophylactic surgery according to accepted principles especially in view of the age and constitutional state of the victims and additionally on account of the established therapeutic value of X radiation The natural tendency therefore would be if these explanations are valid to resort to inguinal dissection only when the glands are easily palpable and after attempts to reduce them by treatment of the septic element in the primary

* *Brit. Journ. Radiol.*, 1935, viii, 806.
† *Acta chir Belg.*, March, 1940, No. 3, 308.

growth or X ray therapy have failed. Statistics must show poor results of gland excision if these principles are adopted especially is this to be expected in centres more liberally equipped with facilities for therapeutic radiation So far it has not been possible to study results in a series of cases where prophylactic inguinal dissection has been employed as a routine whether glands are palpable or not. The nearest approach to such a series is supplied by Lewis* reporting upon 84 cases operated upon over a period of 10 years by the H H Young s technique (see p 2154) Of this number 15 were alive and well 6 five years 2 four years 2 three years and the rest under three years after operation Similarly energetic surgery produced satisfactory results in the collected statistics of Leighton† who treated surgically 34 out of 48 cases 8 cases by partial amputation 5 cases by partial amputation with inguinal dissection 1 case by total amputation 11 cases by total amputation with inguinal dissection and 14 by total emasculation Of the 29 cases traced 19 are living from 6 months to 25 years after operation 3 out of 4 cases treated by röntgen or radium therapy alone were dead.

Barringer and Dean s analysis of 86 cases‡ gives full details of the treatments selected and their individual results Biopsy reinforced clinical diagnosis in a large percentage of their cases

Horn and Nesbitt§ similarly studied 87 cases treated by combined methods but in these excision of inguinal glands was employed in only 5 cases and then associated with total amputation Of 4 cases treated by partial amputation and X ray therapy to the inguinal glands 1 survived for 10 years Eleven were subjected to total amputation with X ray treatment to the glands and of these 6 were alive from 4 to 8 years Of 5 cases treated by total amputation and groin dissection only 1 was known to have lived (4 years) That groin dissection was withheld in the great majority suggests that in the few cases where it was performed all other measures had failed so that no conclusions can be drawn from these figures on the question of gland excision

A Dean‖ found that only superficial growths without inguinal metastases could be satisfactorily treated by radiation alone or by a conservative operation. Of 18 cases first seen with metastases 82 per cent were known to have died

The present writers believe that the ultimate results are better if a systematic radical removal of the inguinal glands is carried out Undoubtedly the delay in seeking advice is largely to blame for many of the disappointments Barringer and Dean estimated that an average of 14 months elapsed between the appearance of initial symptoms and the commencement of treatment It is therefore reasonable to suppose that if early treatment could be instituted as in the case of the tongue and especially prophylactic glandular

* *Journ. Urol.*, 1931 xxvi, 295.
† *Amer Journ. Cancer* March, 1932, xvi, 251
‡ *Journ. Urol* 1924 xi, 497
§ *Ann. Surg* 1934, c, 180.
‖ *Amer Journ. Roent* 1926, xv 24.

measures namely surgical excision or X radiation a better outlook could be anticipated Cade* states that if the treatment of the primary lesion is by radiation alone no decision as to the treatment of the glands should be taken until the result of the treatment of the primary lesion can be assessed He prefers teleradium in treating the inguinal glands and in any case if these are fixed and inoperable external radiation may produce diminution in size and help to clean up foul-smelling ulcers

THE OPERATION FOR VARICOCELE

The main problem of this operation is the selection of cases for in the majority of patients the condition is purely psychological and will either disappear on marriage or continue without producing symptoms Few subjects of varicocele are likely to develop any complication other than pain Thrombosis and rupture of the veins from direct injury do occur but are extremely rare The personal equation is the intangible factor in pain those who declare that they suffer much from the pain of varicocele are precisely those who may complain later of painful scars or of severe symptoms from a hydrocele which may subsequently develop The development of varicocele in men over thirty suggests some new lesion such as malignant kidney Undoubtedly when varicocele is associated with an unusually pendulous scrotum operation is often indicated especially in those whose occupation will take them to tropical countries particularly if hard horse-riding is likely to be required

In the course of examination it must be remembered that a co-existing hernia may be responsible for the pain. Neuralgia testis is another cause and this naturally will not be relieved by a varicocele operation The worst combination is varicocele with sexual hypochondriasis and in these patients surgical measures must always be avoided

Operation for Radical Cure of Varicocele

The high or the low operation may be performed.

The high operation exposes the veins by an oblique incision extending from the external ring to the base of the scrotum. The coverings of the vas and veins are cleared and the vas with a few veins and the spermatic artery are separated from the main mass of varicose vessels The latter are freed from the ring to the testicle and double-clamped at either end. Stout catgut ligatures are placed in the grooves made by the end clamps and are securely tied and the veins are divided close to the intermediate clamps thus leaving a mass distal to the ligatures to safeguard against slipping One end of each ligature is left long so that these may be tied together providing a support for the testicle This support may be further strengthened by placing

* *Proc. Roy Soc. of Med.*, 1939 xxxii, 1509. *See* also Winsbury White, "Textbook of Genito-Urinary Surgery" 1948, p. 617

sutures between the upper and lower occluded vein ends Some prefer to place the ends side by side and to surround both by encircling ligatures Great care is required to ensure perfect control of the cut vessels as many cases of severe hæmorrhage have followed a less cautious technique.

The low operation approaches the veins through an antero-external vertical scrotal incision which divides the dartos as it is deepened towards the vessels The further steps of the operation are the same as for the high approach

In cases associated with a **pendulous scrotum** not only should the ligatures of the central and peripheral ends of the veins be tied together to elevate the testicle but a segment of scrotal skin should be removed This may be done either by excising an elliptical-shaped piece on the anterior surface or—and perhaps preferably—a transverse segment may be removed from both sides The latter is conveniently done by taking hold of the excess portion of the scrotum with an intestinal clamp All tissue on the distal side of this clamp is then removed with scissors and a series of mattress-sutures introduced to check bleeding and to evert the skin edges which are then sutured by interrupted silkworm-gut stitches

Results.—Although the risks of operation are almost negligible the end results often leave much to be desired Corner and Nitch* reviewed 100 cases of which one-fifth still suffered pain and in 4 per cent the patients were even worse for the operation A hydrocele was present in 28 cases and a spermatocele in 2 In 2 there was recurrence Fibrosis and atrophy of the testicle are both found in a high percentage of the cases (55 and 21 respectively) However although these figures reveal a somewhat unsatisfactory state of affairs quite 70 per cent of the patients were comfortable and well satisfied with the operation As a rule intervention is determined by the regulations of some public service but if the operation is performed only when there are definite indications and with cautious case selection the results are good

OPERATIONS FOR HYDROCELE

The operations commonly performed for hydrocele are either (*a*) extirpation of the parietal layer of the tunica vaginalis or (*b*) eversion of the sac (Jaboulay's operation) In both the tunic may be approached through an inguinal or a scrotal incision according to the individual practice of the operator The wound should heal well in either operation the former route however presents opportunity for dealing with a hernial sac should one co-exist

(*a*) **The radical operation.**—All coverings should be peeled off the tunic before opening the sac The distension by the fluid, especially if accentuated by suitable pressure on the scrotum will assist this

* *Brit. Med. Journ.*, 1906, i, 191

and will also help in freeing the vas and vessels If all the coats are got rid of before cutting away the sac there will be fewer vessels to bleed and to form what may be a troublesome hæmatoma The vas and vessels should be separated from the sac before it is opened. Having opened the sac and evacuated the fluid the surgeon cuts away the parietal serous layer with scissors ½ in from the testicle and epididymis. A continuous fine catgut suture is then introduced all along this cut edge to check oozing (Fig 1081) In spite of the greatest care to procure hæmostasis it is necessary to insert a rubber drain which is introduced into the lowest part of the scrotum whether the high or the low operation has been adopted it should be left in for three days.

(*b*) **The eversion operation** —In this it is not so necessary though still advisable to separate all the coverings neither is delivery of the whole sac through the wound essential hence the operation may be carried out very speedily An opening is made into the tunica and after the fluid has escaped it is enlarged to allow the testicle to be brought through it by this manœuvre eversion of the sac will be procured. One or two sutures placed in the edge of the tunic behind the testicle will maintain the eversion but care must be taken that these are not drawn too tightly otherwise interference with the blood supply of the testicle will result Though simple and rapid this operation is not suitable in all cases Thus when the tunic is voluminous or much thickened and adherent eversion may be difficult and should it be attempted a troublesome lump will remain which is often especially in hypochondriacal patients a source of pain and mental disturbance

Excision of a spermatocele.—Spermatoceles if of a size sufficient to warrant removal may be approached by the inguinal or the scrotal route Sometimes they can be completely enucleated without being opened if this is not possible the sac wall is cleared as in hydrocele excision opened and cut away with scissors from the epididymis precaution being taken to leave a sufficiency to hold a continuous hæmostatic suture

After removal of spermatoceles and as a precaution against recurrence it is necessary to examine the epididymis carefully for in a number of cases it will be found that this structure presents a few small cysts or a cystic condition the forerunners of future spermatoceles Partial or complete epididymectomy is the best safeguard against relapse but where the residual cysts are very small and rudimentary some surgeons rely upon multiple puncture

In removal of hydroceles and spermatoceles the high frequency cutting current has been found useful in the dissection of the sacs on account of its hæmostatic action

Results of operations for hydrocele —Excision of a hydrocele if efficiently performed is very rarely followed by recurrence This

might however result from re-collection in a pouch such as the digital fossa or where a bilocular hydrocele was present and the second sac not recognized The results of eversion are not so good and recurrence

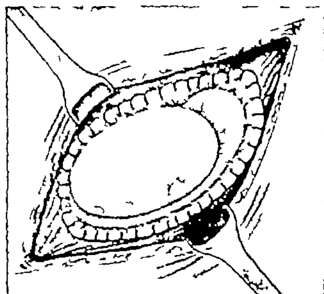


Fig. 1085 —Radical cure of hydrocele.
A continuous haemostatic suture has been placed in the stump of the parietal tunic.

has been met Further atrophy of the testicle may result if the vas or vessels have been compressed by the margins of the opening in the tunica vaginalis

OPERATIONS ON THE EPIDIDYMIS AND VAS

Ligation of the Vasa Efferentia—The Steinach II Operation

Niehans under the influence of Steinach is responsible for the publicity of this operation in England as well as in Switzerland. By ligation of the efferent ducts of the epididymis it is claimed that the symptoms of prostatism are ameliorated but failure is acknowledged in cases where the gland is so enlarged that nothing short of enucleation can be effective The ligation it is suggested by damming back the testicular hormone drives it into the circulation where it activates the inhibiting hormones of prostatic development whether these be of the pituitary or of other elements of the endocrine chain There is however no pathological or clinical evidence to support this.

The **technique** is extremely simple Under 1 per cent. novocain anæsthesia a 1½-in incision over the cord in the scrotum opens the tunica vaginalis The testicle is delivered and a needle threaded with silk transfixes the base of the digital fossa. The stitch is carried round and falls into the gutter between the head of the epididymis and the upper pole of the testicle and is tightly tied. This includes

all the ducts If no gutter exists a shallow incision is made allowing the ligature to fall into place without puckering or causing undue tension in the tunica albuginea of the testicle or epididymis

We have seen several patients upon whom prostatectomy had subsequently to be performed The main objection to the method is that in cases bordering on uræmia valuable time may be wasted in exploiting this operation especially as it is put forward that good results may not be obtained for many months During this probation period uræmia may have become established beyond hope of recovery This operation has been given up by urologists in Great Britain

Epididymectomy

This operation is rarely called for in any condition other than tuberculous disease Occasionally it is required in cystic disease and it is sometimes performed in conjunction with vaso-testicular anastomosis In tuberculosis removal of the epididymis with conservation of the body of the testicle may be considered in all cases where there is reason to believe that the tuberculous disease has not spread into the testicle In some cases this will not become evident until the operation is in progress when orchidectomy can still be carried out if necessary In cases of doubtful diagnosis it is unwise to make an incision into or to take a scraping of the epididymis or of the body of the testicle for fear of dissemination of the disease locally or to distant parts It is better to treat a doubtful case as one of tuberculosis than to delay operative measures too long

Views on the nature and extent of removal of diseased tissue in tuberculous epididymitis vary Some recommend conservative measures such as incision and scraping while others believe in radical removal of the whole of the genital tract including the whole length of the vas the body of the testicle the seminal vesicles and the prostate Most surgeons adopt an intermediate plan and are content with removal of the epididymis and vas up to the internal abdominal ring preserving the body of the testicle as opportunity permits In many cases deposits are already present in the prostate and seminal vesicles but experience shows that in the great majority these improve or disappear after epididymectomy or orchidectomy an observation which is of ætiological interest and supports the theory that the primary lesion is in the epididymis Barney* in 118 cases found prostatic and vesicular lesions cleared up in over 60 per cent. of cases The operation is only one part of the treatment and it should be followed by long courses of general therapeutic measures including streptomycin administration dieting and heliotherapy

Technique —Since the vas must be removed as far as the internal abdominal ring an inguinal incision is necessary but in some cases where there are abscesses or sinuses in the scrotum removal of the epididymis must be carried out through the scrotum to avoid infection of the inguinal region.

* Cabot *Med. Urol* 1936.

(1) **In uncomplicated cases** an incision is made over the inguinal canal extending from ½ in lateral to the internal abdominal ring and carried down to the spine of the pubis the external oblique is split in the direction of its fibres and the inguinal canal thus laid open and the cord defined A finger is then passed down into the scrotum separating the testicle in the tunica vaginalis from the scrotal integuments and delivering the whole through the inguinal incision. The vas is separated from the other constituents of the cord up to the internal abdominal ring clamped, ligated divided and its cut end cauterized with pure carbolic The tunica vaginalis is laid open and the epididymis separated from the body wherever the plane of cleavage is best defined tracing the vas down from above may help in separating the globus major The greatest care must be exercised to prevent damage to the spermatic artery as the future existence of the corpus testis depends upon its preservation Bleeding points are picked up and ligated and the testicle is replaced in the scrotum. The inguinal canal is repaired by suturing the external oblique fibres and if necessary the conjoined tendon to Poupart s ligament if there appears to be undue laxity Dependent drainage in the scrotum is established in every case to guard against hæmatoma.

Miller* describes a technique for avoiding this damage. The testicular artery gives off its branches to the epididymis by dividing above the head of the latter A 2-in transverse scrotal incision is made and the tunica vaginalis opened enough to allow evagination of the testis The skin and dartos are separated from the external spermatic fascia so as to bring the cord and its coverings outside the wound. Straight Mayo scissors are pushed into the sinus of the epididymis and on up the cord until the points present at the upper limit of the tunica. The fasciæ over the scissors are divided and the arteries to the epididymis can then be seen and ligated with the scissors still in position the tail of the epididymis is dissected free and then the head is separated

(2) **Where abscesses or sinuses are present in the scrotum.**—To prevent infection of the inguinal incision it is better to perform the operation in two sections (*a*) Through an inguinal incision the vas is defined and separated as in the last operation as far down as the incision will allow and the cauterized end is surrounded with gauze while the wound is being stitched in all except its lowest part where the cut vas is lying outside the skin incision The wound is covered with protective gauze to avoid soiling during the second stage. (*b*) Scrotal removal of the epididymis Sinuses or suppurating areas are surrounded by elliptical incisions which are deepened until the tunica vaginalis is exposed. The latter is carefully separated from the scrotum endeavouring to avoid opening up septic collections The whole mass is delivered with attached skin outside the scrotum and the tunica vaginalis is entered There may be considerable difficulty in separating the epididymis

* *Brit. Journ. Urol.*, 1948, xx, 1, 15.

this step will be rendered easier by defining and separating the vas as it lies in the lowest part of the cord then tracing it into the epididymis, where the plane of cleavage will be shown In the separation of the epididymis it may be found that tuberculous foci are invading the body the degree of invasion must decide whether the testicle should be sacrificed The vas is separated up to the point where traction on the epididymis will draw the higher section of the vas already freed in the inguinal stage of the operation down into the scrotum when the whole can be removed The scrotal skin is loosely drawn together by interrupted sutures ample room being left for drainage

Division and Ligation of the Vas Deferens

This is performed as part of the operation of epididymectomy orchidectomy and seminal vesiculectomy but it is sometimes carried out independently with the object of checking the spread of infection from the deep urethra seminal vesicles and prostate by the path of the vas or its lymphatics to the epididymis and testicle. It is then a means of preventing epididymo-orchitis where deep-seated infection already exists or as a prophylactic measure where it may be anticipated as a complication after endoscopic resection or other operations upon the prostate

In general tuberculosis division and ligation of the opposite vas are adopted as supplemental to epididymectomy or orchidectomy in unilateral disease by those who hold that a focus in the prostate or vesicle is responsible for involvement of the epididymis or body of the testicle There appears to be no justification for claims formerly made that vas ligation influences prostatic development or controls hormonal balance in such a way as to induce rejuvenation

Technique.—Introduction of 1 per cent novocain into the skin and substance of the cord procures adequate local anæsthesia. The vas projected under the skin by digital counter pressure is under pinned with a curved triangular needle exposed freed and delivered cleared of its coverings to avoid inclusion of the spermatic artery and grasped with two pairs of artery forceps (Fig 1086) It is divided between the forceps and the ends are ligated

Repair of the Vas Deferens

The vas may be accidentally divided in the course of an operation for hernia varicocele or hydrocele or it may be torn in accidents and it has been maliciously divided by jealous women When the injury is recent the usual technique is adaptation of the ends previously bevelled to offer wider surfaces for union and suture with interrupted 6/0 catgut introduced on round atraumatic needles In long-standing injuries the ends of the vas are retracted and obliterated they must be found and the extremities pared down until the lumina are exposed.

In securing accurate apposition and for preservation of the lumen it is useful to have some form of internal splint This may be temporary

where a fine needle is entered into both cut ends and removed at the completion of the operation by grasping the pointed end which is made to pierce the vas wall A splint of catgut or silkworm gut may be allowed to remain the former until it absorbs the latter for a few days Where catgut is used, a 2-in length of 000 is threaded at each end on fine needles These are passed eye-end into the vas openings unthread themselves and leave the catgut *in situ* as they are withdrawn. An easier method is to use fine silkworm gut the needle carrying it is passed eye-end into one end of the vas and unthreaded within the vas by pushing in a greater length of needle than the length of silkworm gut projecting beyond the eye The needle is re-threaded and passed point-end first up the other open end of the vas it transfixes the wall one inch up The end will be attached to the skin surface ready for removal on the fourth day

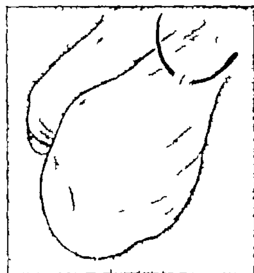


Fig 1086 —Exposure of the vas deferens.

The vas is projected under the skin of the side of the scrotum by the finger and fixed by under-pinning with a curved cutting edge needle. The dotted line represents the line of the incision.

Results.—There is evidence that the functional continuity of the vas can be restored by this operation *

Injection of the Vas Deferens—Vesiculography

Belfield s operation† has been mainly employed to overcome chronic gonorrhœal seminal vesiculitis clinically responsible for relapsing epididymitis persistent urethral discharge and iritis but modern treatment of gonococcal and non-gonococcal infections have made it a thing of the past It is now employed mainly for radiography of the seminal vesicles (vesiculography)

Technique.—The vas is delivered through a 1 in scrotal incision and cleared thoroughly of its coverings so that a neat incision into its lumen can be made It is better to open in the long axis than by a transverse incision as the latter is almost certain to cause a permanent block About 5 c c. of lipiodol is introduced through a blunted hypodermic needle Any excess of injection will escape into the urethra after it has overflowed from the vesicle.

Anastomosis of the Vas Deferens to the Rete Testis

This operation is performed for sterility resulting from an epididymitis which has caused permanent obstruction to the escape of spermatozoa

* Praberg and Lepsky *Journ Urol.*, 1939, xli, 644.
† *Journ. Amer Med Assoc* 1913, lxi, 1867

from the testicle Before it is undertaken it is desirable to ascertain (*a*) that the vas is patent at its urethral end and (*b*) that spermatogenesis is active in the testicle The former may be proved by exposing the vas as in the operation for ligation injecting a dye e g methylene blue and observing its escape from the urethra the latter by puncturing the testicle with a large bore exploring needle and examining the material withdrawn microscopically for living spermatozoa.

The anastomosis will be rendered more simple if combined with a partial epididymectomy The vas is divided opposite the globus minor and split for ½ in The open end is then laid upon the rete testis which should be scarified if the previous epididymectomy has not sufficiently laid open the substance of the organ Interrupted fine catgut sutures passed between the edge of the split vas and the tunica albuginea of the testicle will preserve contact and the union may be reinforced by suturing the scrotal connective tissues carefully around the anastomosis

Martin* has described the operation of epididymo-vasotomy in which the vas is anastomosed to the globus major where fibrosis of the globus minor is the obstructing element His method bears so close a resemblance to the description given above that no detailed account is necessary Very fine silver wire is used to unite the vas to the epididymis Motile spermatozoa have been found in the seminal fluid after this operation

VASECTOMY

A part or the whole length of the vas deferens may require removal. A short length may be excised in the scrotum to procure sterility Mere division has been followed by a natural re-union with canalization in human beings and in animal experiments To render this impossible a short segment is resected or the duct is divided followed by lateral suture of the terminal ½ in of the divided ends

In castration for trauma vascular derangements inflammations and new growths as much of the vas is removed with the testicle or epididymis as the primary lesion demands In tuberculous disease the vas is always taken as far as the internal abdominal ring H H Young† regards this as too conservative and describes the removal of the whole length as far as its ampulla through an extraperitoneal abdominal approach Should excision of the seminal vesicles and the prostate also be considered necessary these with the ampullary end of the vas may be removed by access through an inverted U-shaped perineal incision ‡ which may be combined with the abdominal operation.

OPERATIONS ON THE TESTIS

ORCHIDECTOMY

The indications for orchidectomy are

(1) Certain cases of undescended and misplaced testicle
(2) Certain injuries i e severe contusions and gunshot wounds
(3) Torsion of the cord producing necrosis of the testicle

* *Penn Med. Bull* March, 1902, xv 2 *Therap Gaz* Dec. 15, 1909 xxv 837
† *Pract. Urol* 1926, i, 376.
‡ *Arch. Surg* 1922, iv 334

(4) Inflammatory infections—(a) *Acute* B coli and pyogenic infections (b) *Chronic* tuberculous disease syphilis. B coli and pyogenic infections

(5) New growths whatever their histological structure as all are malignant or potentially so

Two varieties of operative removal are possible (a) local, and (b) radical.

(a) **The local operation** consists of tying off the cord in the inguinal region either with a ligature which includes all structures *en masse* or by transfixing with a threaded aneurysm needle and ligating in two sections the ligatures being interlocked to prevent slipping Where tuberculous or pyogenic infection exists a strict ritual of toilet of the divided vas isolation cauterization and ligation must be faithfully followed. It is usual to divide the vas at the internal ring in tuberculous cases unless the operator elects to take it as far as the vesicles or even to include them and the prostate Statistics do not appear to have proved the value of the radical procedure (see p 2464)

In malignant disease the problem is complicated. The unsatisfactory results of simple orchidectomy before the introduction of irradiation led to heroic attempts to eradicate the disease *en masse* Reversion to the local operation is now almost universal for the radical operation never had a recovery rate justifying its adoption and further X-ray treatment has been shown to offer a better prospect of cure than far reaching operative surgery As a safeguard division of the cord in the inguinal region with the diathermy knife should be an early step of the operation. Pre-operative and post-operative irradiation of the lumbar lymphatic field is a very necessary supplement

(b) **The radical operation.**—Chevassu Bland Sutton and Morriston Davies were responsible for the pioneer efforts to establish the merits of this operation in the early years of the present century More recently Hinman has been the chief contributor to the literature recording favourable experiences of the operation supplemented by radium and X ray therapy The object of this operation is to remove the testicle the whole cord and the corresponding abdominal lymph nodes *en bloc*

The operation is followed by considerable shock and as admitted by Hinman* in his earliest series has an 11 per cent. operative mortality

Further considerations.—When undertaking treatment of a testicular tumour its nature degree of malignancy and radiosensitivity should theoretically be tested by all available means for the choice of procedure and the prognosis will be influenced by recognition of the type in question Biopsy apart from orchidectomy is unjustifiable from the risk of dissemination Radical treatment has now been given up since it has been found that orchidectomy and post-operative X radiation of the abdominal glands give better results The more differen

* *Journ. Amer Med Assoc* Dec., 1914 lxiii, 2009.

tiated adult-celled teratoid tumours and most of all the chorion epitheliomata show an ascending grade of radio-resistance as proved by the therapeutic test of irradiation In these an early operation offers the only hope of prolonging life

Assistance in the diagnosis prognosis and choice of treatment as well as inference on recurrence or metastases is provided by the Aschheim Zondek biological test which depends upon the presence of chorionic hormone in the urine This hormone injected into female mice produces within a week easily recognizable changes in the uterus and ovaries In this way biological activity is a measurable quantity and is represented in mouse units Radio resistance runs parallel to the number of mouse units thus the seminomata the most radio-sensitive tumours will show only some 500 whereas at the other end of the scale the chorion-epitheliomata average 100 000 units With radiosensitive tumours a single exposure may induce a considerable fall in the prolan excretion disappearance is regarded as indicative of cure and reappearance signifies recurrence or metastasis It is said that over 90 per cent of testicular tumours will give a positive Zondek reaction but the present authors think that this is a high figure The majority show a low prolan content and being radiosensitive the prognosis in these the so-called seminomata, is not unfavourable

Results of Operations for Tuberculous Disease of the Epididymis and Testicle

This disease so often a manifestation of low resistance is in consequence frequently associated with urinary and extra urinary foci and has a high mortality whatever treatment be adopted Genital tuberculosis being *per se* non lethal operations have little influence upon expectation of life but a very considerable influence on neighbouring and associated lesions in the genito-urinary apparatus The effect of epididymectomy in conserving and safeguarding the testicle is proved and in view of the probability of contra lateral involvement with possibly rapid invasion of the testicle results have established beyond question that the endocrine function of the primary side involved can be protected by epididymectomy

Apart from such local effects of a limited operation more distant influences are observed Reference has already been made to diminution and even to disappearance of foci in the vesicles and prostate following epididymectomy or orchidectomy (p 2467) Barney and others including Lee and Bowes* have found such favourable results the latter authors found later recurrence of these lesions in 4 0 per cent of cases who had been subjected to either operation

An equally important matter for consideration is the relative influence of a conservative operation epididymectomy or orchidectomy with limited vasectomy and a radical (i e additional) removal of the whole length of the vas deferens and the vesicles upon prevention of invasion of the opposite epididymis Von Bruns†

* *Brit. Journ. Surg.*, 1934 xi, 83 439
† *Centralbl. Chir* 1901 xviii (Beilage), 119

after the former found the percentage of contra lateral invasion to be as high as 29 More recently Thomson Walker was forced to a similar conclusion regarding the incidence of opposite side involvement this often appearing within a year of operation and Lee and Bowes found 38 5 per cent of such recurrences in 62 cases where the vesicles had already shown signs of involvement at the time of the original operation Sanford found 20 within from three months to one or more years after 77 cases of epididymo-vasectomy On the other hand, Horwitz* found more favourable results and V C. Hunt† only met opposite recurrence in 2 out of 88 cases subjected to epididymectomy the remainder keeping free for periods up to five years Lee and Bowes studied the influence of the radical operation in 16 cases in which the vesicles were involved they found opposite recurrence in 37 5 per cent. of cases which closely resembled the incidence of recurrence after the limited operation (*vide supra*)

The mortality rate of tuberculous epididymitis was studied by Sanford in an entire series of 156 cases over a period of 20 years 72 were known to have died 42 many of whom were inoperable died within two years of the onset of epididymitis 81 patients who had been subjected to a conservative operation were alive and well one to five years after leaving hospital 1 patient was alive two years after the radical operation and 2 others so treated were not traced. Loughnan‡ reported a series of 21 radical operations with an operative mortality of 9 5 per cent Two more cases died within four years and the remaining 17 were alive from one to ten years after the operation Cosbie Ross§ and others have recently reported improved results in the surgery of genital tuberculosis but specific antibiotic therapy has not displaced the need for epididymectomy This is performed under an antibiotic umbrella.

Results of Operations for Malignant Disease of the Testicle

Among the reports of earlier writers where simple castration alone was performed 30 out of 48 cases showed metastases in the retroperitoneal glands within a year (Kober) Hinman found 81 out of 100 cases were dead within four years ‖ Tanner in 1922 found only 5 5 per cent of 465 castrated subjects alive four years after operation. With the advent of X radiation a more optimistic outlook became possible Dean in 1929 by the full use of radium and X rays either supplementary to operation or independently was able in the operable cases to find 13 out of 16 living and well 4 for more than four years Of the inoperable class 8 were living four years after commencement of treatment 24 for shorter periods

Cairns¶ reported no post-operative mortality for the radical operation

* *Journ Amer Med. Assoc.*, 1902, xxxviii, 1607
† *Arch. Surg.*, 1924, viii, 811
‡ *Proc Roy Soc. of Med* 1944, xxxviii, i, 25
§ *Brit. J Urol* 1943, xxv 282.
‖ *Journ Amer Med Assoc* Dec., 1914, lxiii, 2009
¶ *Lancet*, 1926, i, 843.

and 5 out of 19 cases later showed no sign of recurrence By far the longest series was studied and reported by Hinman in 1933* 100 cases showed a 17 per cent five-year cure including 4 cases which were found at operation to have pre aortic metastases In 1935† 10 of his personal 14 cases were living one to ten years after operation of the survivors between one and fourteen years 4 had been found at operation to have metastases The tumours in 11 of the 14 cases were radio-resistant mixed-celled teratomata. A case of chorion epithelioma died of metastases 10 months after operation These figures justify his more optimistic outlook and support his contention that the radical operation with the aid of radium and X radiation can claim 30 per cent of cures

Gordon Taylor and Till‡ have found the results of the radical operation less favourable and confine their treatment to the combination of X ray therapy and local orchidectomy Referring to the results of operation where malignancy supervened in 15 personal cases of retained testicle of which 8 were abdominal and 7 inguinal retentions Gordon Taylor states that 3 of the inguinal cases were cured by local operation and X ray treatment in the abdominal cases life was very brief whatever treatment was adopted. More recently Gordon Taylor and Wyndham§ have collected and reviewed 700 cases They advocate simple orchidectomy and abdominal radiation. At 10 years 23 9 per cent were alive and several isolated survivals of as long as 8 10 and 26 years are reported

Operations for Imperfect Migration of the Testicle

The testicle may be arrested at any point in its normal path of descent (incompletely descended testicle) or drawn aside into an abnormal position (ectopia testis) John Hunter considered that defective structure deficient function and failure to reach the scrotum combined to express a state of imperfect development Degeneration of the spermatogenetic cells according to Monod, accounted for the sterility of cryptorchids Environment especially unsuitable temperature is believed by Wangensteen and others to account for imperfect development of the extra-scrotal testicle a theory supported by the animal experiments of Carl Moore‖ and the recordings of intra scrotal and peritoneal temperatures in 80 young adults made by Badenoch in 1945 ¶ Up to the age of 10 or even puberty little if any histological peculiarity can be recognized in the retained gonad later the testicle is relatively small spermatogenetic cells are either degenerate or replaced by sustentacular cells but interstitial (Leydig) cells are increased in number Evidence that endocrine balance is at fault is provided by the associated penile and scrotal under-development in a fair proportion of double cryptorchids The problem of

* *Surg Gyn. Obst.*, Feb., 1933, lvi, 430.
† *Journ. Urol* July 1935, xxxiv 72.
‡ *Brit. Journ. Urol.*, March, 1938, x, 1
§ *Brit. Journ. Surg* XXXV cxxxvii, 6.
‖ *Anat. Rec.*, 1922, xxiv 383
¶ *Brit. Med. Journ* ii, 601

the physiological value of the imperfectly descended testicle is not yet fully solved. The endocrine function is held to be little affected when secondary male characteristics are present in double cryptorchids. Spermatogenesis is generally regarded as aborted where the testicles have failed to reach the scrotum naturally by puberty. It is necessary to verify that inguinal testicles are not merely retractile for these are anatomical accidents and need not come within the category of arrested development (*vide infra*). Examples of parentage in double cryptorchids may be thus explained.

Hormone treatment.—Interest has been added to the ætiology of imperfectly descended testicles by the discovery that a hormone of pregnancy (pregnyl) influences development and descent. Extended trials of this substance have shown its limitations and indicate that successes are only to be expected in so-called movable inguinal testicles the very cases which would in all probability have descended automatically in course of time for it must be realised that spontaneous descent of the testicle after puberty is not as uncommon as is generally supposed. Drake * studying late descent in schoolboys found that 22 testicles arrested before puberty were descended between the ages of 15 and 17 years. R. E. Smith† similarly calls attention to the frequency of descent at or soon after puberty and recommends that biological treatment should be deferred until then.

Spence and Scowen ‡ analysing the results of hormone treatment in 66 bilateral and 82 unilateral cryptorchids regarded this as likely to succeed in the absence of an anatomical hindrance but considered the universal success in retractile testes no tribute to hormone therapy since all such glands descend without any treatment. Of the movable inguinal testes 76 per cent of the bilateral and 64 per cent of the unilateral examples responded but on those which were impalpable or immovable treatment failed. If therefore no improvement could be observed after a six months trial an anatomical defect was suspected and operation accordingly advised. Neither undue enlargement of the penis nor degenerative change in the testicles was observed as the result of biological treatment. The dose employed should not be less than 500 rat units given intramuscularly twice a week. Hormone treatment is considered inadvisable below the age of 10 from fear of inducing precocious puberty. No improvement was seen in any case over 18 years of age.

Mimpriss § while carrying out an investigation on the influence of pregnyl saw that spontaneous descent took place in a high proportion of his untreated controls as the testicles developed in succeeding years. Retention in the controls was of a similar type to that seen when success was attained by hormone therapy. He also made experimental examination of structural alterations within the testicle induced by pregnyl using immature rats. Where the testicles were descended

* *Journ. Amer. Med. Assoc.*, 1934, cii, 759.
† *Proc. Roy. Soc. of Med.* 1937 xxx, 1327.
‡ *Lancet*, Oct., 1938, ii, 983.
§ *Lancet*, March, 1938, i, 533.

an early stimulus to growth was followed by a lag but no degenerative changes took place In those testicles in which artificial retention had been produced the same stimulus and lag were found but in addition definite degeneration was found in the tubular epithelium with intertubular fibrosis Denis Browne* reserves hormone therapy for cases showing a lack of sexual development and states that in his opinion testicular atrophy can occur from overdosage of gonadotrophic substances

So far it may be said that hormone therapy has had little more influence upon the surgery of imperfectly descended testicles than to postpone operation while awaiting a fair trial of pregnyl Formerly the eighth year was considered to be the most suitable for operation now most surgeons prefer to wait until the tenth or twelfth or even until the period of puberty is past for delay introduces no additional difficulties into the operative technique development of the testicle is little if at all influenced and function may be discounted If however a hernia is present giving pain threatening a weakness of the abdominal wall or showing a tendency to strangulate operation must be proceeded with at possibly a much earlier age A symptomless hernia is no indication for an operation indeed it may be an asset through burrowing a track or keeping open a path of descent

Choice of treatment.—Apart from the necessity for operation dictated by a hernia or torsion of the testis no agreement has been reached and, until prolonged trial and late results of hormone treatment are available is not to be expected No doubt imperfect appreciation of the mechanical factors responsible for the abnormality accounts in part for the difficulty of making decisions Denis Browne† has pointed out the laxity of anatomical descriptions for instance the statement that a testicle palpable in the inguinal region is retained in the inguinal canal This is impossible for so soft and attenuated a structure could never be felt through the strong aponeurosis of the external oblique muscle A palpable and possibly visible testicle in the position of the inguinal canal really lies superficial to the aponeurosis in the superficial inguinal pouch having arrived in this position either by being retracted from the scrotum over the bar of the pubic bone by an over active cremaster or dartos or having been prevented from ever reaching the scrotum by an abnormal attachment of Scarpa s fascia to the pubic bone A testicle in this position is in fact ectopic a true undescended inguinal testicle if outside the abdomen must lie either in the inguinal canal when it is impalpable or at or just below the external ring One of this category lying below the canal is apt to disappear and be lost in the depth of the canal but can sometimes be made to re-appear on coughing or straining being aided in its excursions by the hernial sac which invariably accompanies this type this is the elusive testicle (so-called by Grey Turner) In most cases the true inguinal testicle can only be proved as such and distinguished from the abdominal organ at operation.

* *Proc Roy Soc. of Med.*, 1949, XLII ix, 643
† *Brit. Med. Journ.*, July 23, 1938, ii, 161.

By consideration of these points the surgeon is in a better position to differentiate in an old enough child between the testicle which is merely retractile and one which is mechanically held up The retractile testicle can be coaxed over the pubic bone to the neck of the scrotum or lower in time it will descend farther and remain in its scrotal bed, but this can be hastened if development is stimulated by pregnyl Operation is always necessary where an anatomical barrier exists as for example the attachment of the fascia of Scarpa to the pubic bone and in many of the true inguinal testicles although in these as in elusive testicles a barrier is hard to prove so that pregnyl should be given ample trial.

Unilateral cases.—In these if impalpable or immovable the tendency will be to operate at an earlier age for assuming that the other testicle is well developed an endocrine imbalance cannot be held *responsible and in consequence the biological treatment should not* succeed Since function can almost certainly be excluded and in view of the by no means negligible tendency to malignancy especially referred to by Gordon Taylor and Till * orchidectomy is on purely surgical grounds the wisest course but two scrotal testicles are required in certain services and for psychological reasons orchidopexy may be desirable Abdominal replacement is never indicated.

Bilateral cases.—Grey Turner† regarded these as falling into two groups (*a*) the endocrine-deficient where the external genitalia are *small and ill-developed and* (*b*) *those which exhibit only testicular* lack of descent the penis being normally sometimes abnormally developed In the former group artificial endocrine stimulation is the more important while in the latter operative surgery may supplement or even supplant such treatment. The aim of surgery in all bilateral cases is to implant the testicles in the fundus of the scrotum. If anatomical conditions preclude this one or both gonads should be abdominally replaced in the hope that their endocrine function will survive and preserve secondary male characteristics The risk of future malignancy has to be ignored in this class

Methods of orchidopexy—Three types of operation may be performed

1 Primary placing of the testis into the scrotum of the same side.

2 Primary placing of the testis into the scrotum of the opposite side (Ombrédanne s operation)

3 Temporary fixation of the testis to the fascia lata of the thigh as a step towards scrotal implantation (the Keetley Torek technique)

In the majority of cases of undescended testicle it is possible to elongate attachments sufficiently to allow of emplacement in the scrotal fundus without undue tension. After a long and tedious operation to secure this objective it is highly disappointing three months later to observe that efforts were in vain and that the testicle

* *Brit. Journ. Urol.*, March, 1938, 1

† *Proc. Roy Soc. of Med.*, 1937 xxx, 1321.

has already been drawn to and even makes contact with the pubes The operation which gives the highest percentage of good results namely that with the aid of temporary thigh fixation will be described in detail. The less complicated varieties of operation (1 and 2) will be briefly alluded to and easily understood being simple modifications of the main principles of the early steps of the third

The thigh fixation method (Keetley Torek operation) —C. B Keetley published his original description in the *Lancet* * Fifteen years later Torek† published a full and well illustrated article on the method and thus the operation is often associated with his name Minor modifications were introduced by Wangensteen ‡

Additional advantages of this operation are that the testicle grows while it is in the thigh it may even develop an additional blood supply the cord becomes elongated and the scrotum which is often underdeveloped on the affected side becomes more capacious Ward§ records a case in which unintentionally the scrotum was detached and the testis left in the thigh Several years later it was found to be well developed Both in this country and in America this appears now to be accepted as the operation of choice

(i) *Incision isolation of processus vaginalis and freeing the vas* —An incision is made over the inguinal canal from the level of the internal to the external abdominal ring The external oblique fibres are split divided or separated in this line The testis enclosed in the processus vaginalis and covered by internal spermatic and cremasteric layers can now be identified if it lies in the canal If it lies outside the external ring or superficial to the external oblique in the superficial inguinal pouch it will be readily recognized but if in none of these positions the peritoneal sac must be opened to allow it to be withdrawn from the abdomen The coverings are divided and the serous sac (the processus vaginalis) carefully examined after separating the coverings by gauze dissection. It should be noted if the processus vaginalis is an isolated circumscribed sac representing a tunica vaginalis or as is usually the case whether it is continuous with the peritoneal cavity i e a congenital hernia and if its lower end has descended into the scrotum A fibrous structure the remains of the gubernaculum will be seen descending from the tail of the epididymis and the lower part of the tunica vaginalis into the scrotal pocket in those cases where the processus vaginalis ends abruptly in the inguinal region division of the gubernaculum will easily permit delivery of the testicle with the tunic but care must be taken to avoid injury to the vas which may be looped below the tail of the epididymis The processus vaginalis is now opened to allow inspection of the body of the testis and if the upper end is patent to see whether it is indeed a hernial sac of which the neck has remained unobliterated

* *The Lancet*, 1894, i, 1008.
† *New York Med. Journ.*, 1909, xc, 948.
‡ *Surg. Gyn. Obst.*, 1932, liv 219
§ *Proc. Roy. Soc. of Med* 1947 XL, xiii, 810

If the processus vaginalis extends into the scrotum and is well developed it is better not to attempt to deliver it from the scrotum. It should be opened and explored and then separated from the structures of the cord towards the internal ring Close contact and the friability of the serous sac render this a difficult step which may however be facilitated by injecting saline solution through a hypodermic syringe beneath the serous sac bringing about an automatic separation and aiding the isolation ligation and division of the neck of a hernial sac at the level of the internal ring The finger is next

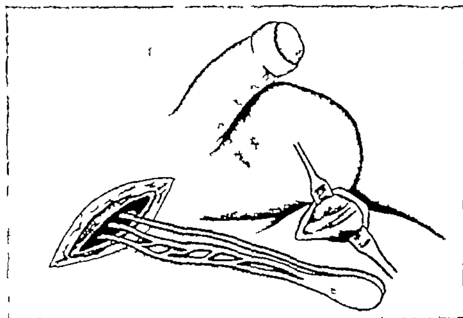


Fig 1087.—The Keetley Torek operation. The testicle has been liberated and adequate length given to the cord and vessels, as described in text. The fascia lata is exposed in the thigh wound.

passed into the internal abdominal ring and peels off the vas from the peritoneum in the depths of the pelvis thus giving additional length to this structure this step being aided by gentle traction on the testis To obtain greater laxity of the spermatic vessels a similar method is adopted the full length of the finger being passed up in the direction of the course of these vessels so mobilizing the peritoneum of the iliac fossa with which the vessels are in intimate contact. Having thus released the vas and vessels greater length may still be obtained by dividing fibrous anchoring bands but in doing so great care must be exercised to avoid division of the spermatic artery for this accident is invariably followed by atrophy of the testicle in spite of the artery of the vas Preservation of the main vessel is therefore an important factor aiding operative success Where an insufficient length of the vas plainly hinders the securing of adequate laxity the deep epigastric artery may be divided at the internal ring or the internal crus of

the internal abdominal ring which overlies the artery divided * but it is better to take the testicle and cord down through Hesselbach s triangle

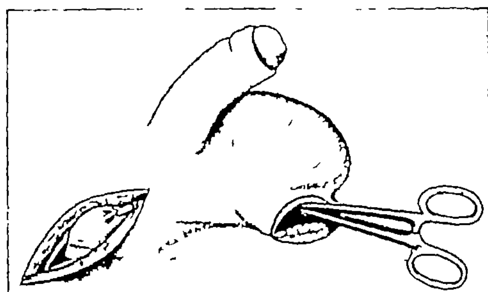


Fig 1088 —The posterior edges of the scrotal and thigh wounds are sutured. A forceps has grasped the gubernacular stump

so that the cord emerges mesial to this vessel and to the internal crus These methods seldom fail to allow the testicle to descend to an even lower level than necessary (Fig 1087)

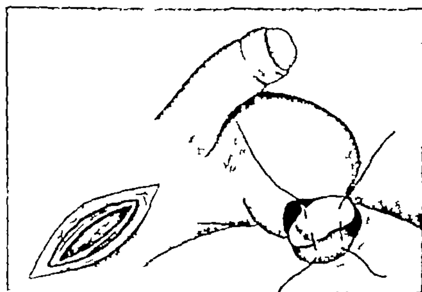


Fig. 1089 —Suturing the testicle to the fascia lata.

(ii) *Preparation of the scrotum* —The scrotum must be prepared to receive the testicle Where the processus vaginalis was of the scrotal variety as already described the index finger passes down within it

* Denis Browne *Lancet*, March, 1933, i, 460.

and is felt to split it as it presses towards and spreads the fundus of the scrotum immediately beneath the skin at the same time carrying the fundus to that area of the thigh elected for union. A one-inch oblique incision is made through the scrotum the finger within it serving as a guide and a means of rendering the lax tissue tense

(iii) *Preparation of the thigh* —A 1 in incision is made in the area selected parallel with that in the scrotum The deep fascia is incised and bleeding arrested. The posterior margins of the thigh and scrotal incisions are sutured with interrupted catgut stitches

(iv) *Suturing the testicle to the thigh* —With long artery forceps passed up through the scrotal wound the stump of the gubernaculum

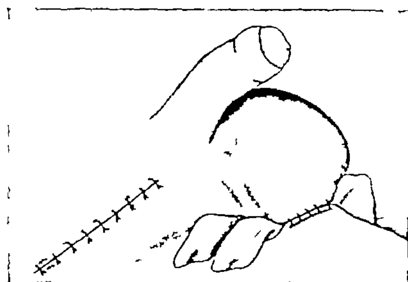


Fig. 1090.—The wounds are sutured. A gauze dressing occupies the space between the thigh and scrotum.

(Figs 1087 1090) are reproduced by permission of M Paul Torek, modified from illustrations "Annals of Surgery")

is seized (Fig 1088) and drawn upon and the testicle is thus brought to the thigh and into contact with its new bed, to which it is fixed by two catgut sutures which pass between the tunica albuginea and the exposed fascia lata. (Fig 1089) (Wangensteen prefers to leave the testicle within the scrotum and only attaches the gubernaculum to the fascia lata.)

(v) *Closure of the wounds* —The anterior margins of the thigh and scrotal incisions are sutured with interrupted silkworm gut A gauze strip is inserted between the scrotum and the thigh above the area of the union The inguinal incision is closed in layers. (Fig 1090)

If there is much tension on the cord the thigh is kept flexed for two or three days The child is allowed up at the end of a week and returns to normal life for from three to six months depending upon the ease with which the testicle could be brought down.

Simultaneous emplacement in bilateral cases is never performed The second testicle is fixed at the same time as the second stage of the first operation i e when the scrotal bridge is separated

(vi) *Separation of the scrotal bridge*—At the selected time usually three to six months after the first operation the union is incised circumferentially the testis is separated and buried in the scrotum which is sutured over it and the thigh wound is closed

Alternative methods of orchidopexy—(1) Primary placing and fixing the testicle into the same side of the scrotum All the preliminary steps are as described A mattress silkworm gut suture takes a firm hold of the tunica albuginea and the ends threaded to long straight needles transfix the scrotal fundus and then may be attached to the skin of the scrotum or inner side of the thigh tied around a gauze roll or rubber tube or to an apparatus such as the Cheyne s cage The cord may be surrounded by a loose purse-string suture applied to the inner aspect of the scrotal integuments as described by Bevan as an additional means of preventing ascent of the testicle

(2) *Ombrédanne s method* *—Again the preliminary steps are the same. A vertical incision is made through the skin of the anterior aspect of the scrotum immediately to the opposite side of the median raphé. The index finger is passed into the scrotum from the groin wound and is made to present at the scrotal wound By deepening the scrotal incision integuments fascia and septum will in turn be divided the septal division being about half an inch in length Artery forceps are passed from the scrotal to the groin incision the fibrous structures at the tail of the epididymis are grasped and the testicle is thus brought to the opposite scrotal pocket If the septal hole appears too lax it can be reduced by one or two sutures

(3) *Denis Browne s operation* †—The skin over the pubis is raised by lifting a self-retaining retractor in the wound. A tunnel appears showing the normal path of testicular descent On the floor of the tunnel between it and the pectineus is a firm distinct band of fascia. The testis is pulled under this from a scrotal incision but no other fixation sutures are used

Abdominal replacement.—This operation is carried out in some cases of bilateral retained testicles in the hope of preserving the internal secretory function when shortness of their attachments will not permit scrotal implantation The whole length of the inguinal canal is opened giving thorough exposure of the internal ring The index finger is passed through the ring into the cellular tissue of the iliac fossa and a bed is prepared in which the testicle is placed. The inguinal canal is then closed by suturing the conjoined tendon to Poupart s ligament and uniting the edges of the external oblique aponeurosis

* *Presse Méd.*, 1910, xviii, 745.
† *Lancet* 1933, i, 460.

This should never be done in cases where one testis is palpable and is either in the scrotum or can be brought there by operation because of the undoubted risk of later malignancy One of the authors (H K V) has had one case in which after performing orchidectomy for incomplete descent with the opposite testicle normally placed, a totally unsuspected seminoma was found in the specimen removed at operation.

Results of orchidopexy—Broca* was one of the first to study results in a series of cases. In 81 (40 per cent.) the testicle was normal in character and position at the end of the first year in 86 (44 per cent) the testicle was normal but the gland had risen to the external ring in 18 (16 per cent) the testicle was atrophied. Tyrrell Grey † adopting the method of Collier i.e. procuring greater length of the spermatic vessels by mobilization of the peritoneum adjacent to the internal abdominal ring reported a short series of results (81 operations) collected up to a period of ten years after operation These are given as perfect in 66 per cent fair in 10 per cent. poor in 16 per cent and in 10 per cent atrophy followed. Perfection is defined according to position size consistence relationship to the epididymis the elements of the cord, and testicular sensation. Burdick and Coley‡ found 60 per cent. of successes in 678 subjects of the Bevan operation. A later observation by them§ reviewing the results of the Torek technique showed strikingly better figures for of 187 cases 120 successes (90 per cent) were recorded, and Walters ‖ reporting upon 100 cases in which the Torek principle had also been adopted in the preceding five years found the results had been uniformly successful even though several intra abdominal testes were included. In only three cases was orchidectomy necessary

Anatomical perfection thus appears a reasonable expectation but the physiological problem remains unsolved assuming that the paucity of evidence of fertility is a criterion Spermatogenesis and proved paternity are difficult matters to investigate especially as the subjects of testicular defects show an inherent and not unnatural reticence. McCollum ¶ however reviewed a series of 89 cases among which 15 bilateral cryptorchids had been subjected to orchidopexy Six of these had begotten children but it was not possible to confirm potential parentage by sperm counts. Of the remainder some showed an adequate spermatozoa content but there was no evidence of parentage while others revealed apparently well-developed testes but aspermia. Hawsen** in a recent survey of a series of 100 cases of testicular maldescent of varying types says that by operation we do not succeed in making the operated testis produce any significant

* *Gaz. Hebdom. Méd. Chir.* 1899 s. iv, 289.
† *Brit. Journ. Surg.*, April, 1930, xvii, 68, 623.
‡ *Ann. Surg.*, 1926, lxxxiv 867
§ *Ibid.*, 1933, xlviii, 496.
‖ Mayo Clinic Reports, 1932, vii, 345.
¶ *Arch. Surg.*, 1934, xxxi, 290.
** *Proc. Roy Soc. of Med.*, 1949, XLII, ix, 645.

amount of spermatozoa The late results of the endocrine treatment will be watched with interest

For assistance in provision of material to illustrate the chapters upon the kidney and ureter the penis and testicle and the urethra the writers are indebted to the *British Journal of Surgery* the *Annals of Surgery* the *Lancet* and *Medical Press and Circular* to *Proceedings of the Royal Society of Medicine* to the late Mr Arthur Edmunds for permission to adapt his drawings and to Mr Paul Torek those of his father and finally to Miss Collinson and the late Mr Thornton Shiells for the several pathological and operative illustrations they have provided

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